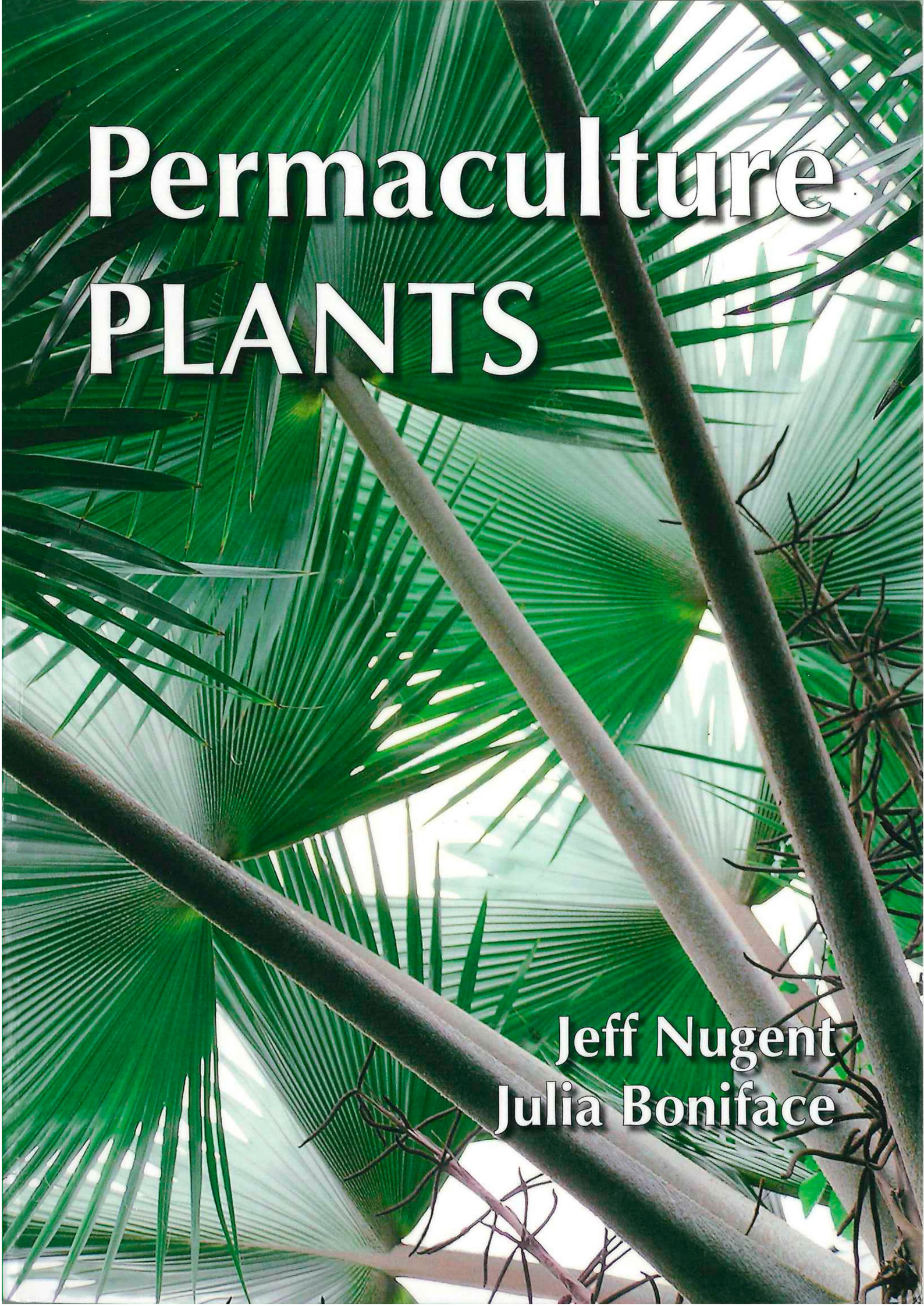
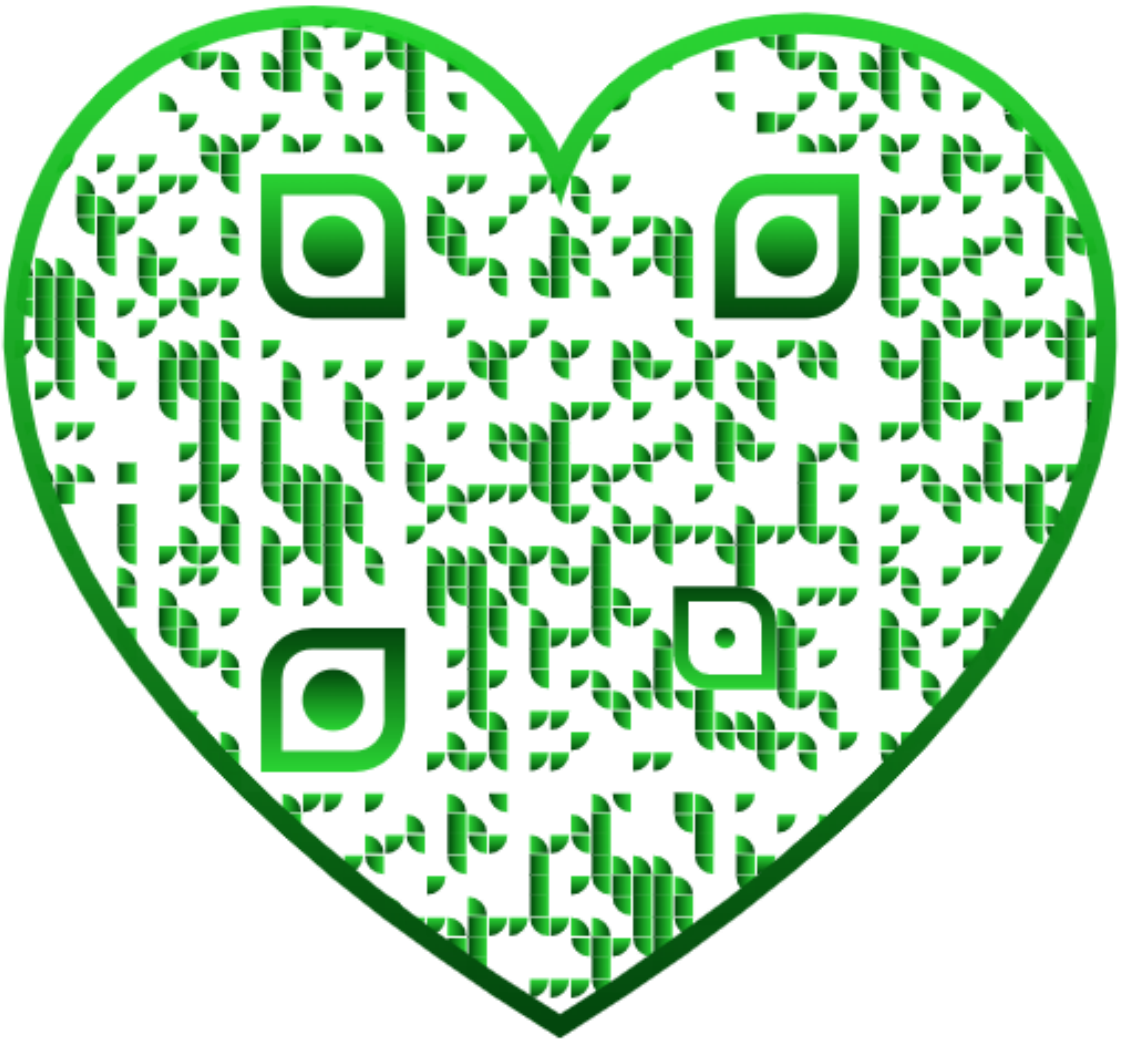

Permaculture
PLANTS
Jeff Nugent
Julia Boniface



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Preface

"It's not ready yet", has been the cry for several years as our students pushed us to publish this book. It's still not. complete of course, because the subject is too vast and there is still so much that we don't, know. There are many species still to be included, but sooner or later we had to say "enough", with the knowledge that the next edition will grow. It. is with humility that we present, this book. The driving force to present it is knowing that it will help others to become more effective in their work.

Although we have made every effort to make the information in this book as accurate as possible, we acknowledge that there may be some information that is incorrect. We take no responsibility for how people vise this information or for any wrong information in this book. We hope to get feed-back from people so that subsequent editions will become more useable. As will become apparent, some sections of the book are still in note form.

We have tended to avoid the more common fruits such as apples, apricots, plums, etc. feeling that, there is readily available information on these species. We have generally avoided cultivars of species, although in some cases we have decided to include these. A seemingly disproportionate space is dedicated to palms, compared to say the useful bamboos. This has largely been a quirk of fate.

Sustainable Agriculture Research institute (SARI)

SARI is based in Nannup, Western Australia. Extension services available through SARI include: property selection and design; nursery stock supply; and planting of systems.

SARI runs courses on Perinaculture, including the Permaculture Design Certificate Course. This is SARI's first major publication.

Both of the authors work as researchers, designers and educators with SARI.

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Jeff Nugent was born in Perth, Western Australia and moved to Nannup in 1975. He is a founding member of SARI. He holds a Diploma in Permaculture and he wishes he had this book 20 years ago.

Julia Boniface moved to Nannup, Western Australia after completing a Degree in Agriculture at London University in 1989. She holds a Certificate in Permaculture Design, and now works as a Permaculture designer and lecturer with SARI.

Dedication

This book is dedicated to future generations who face the enormous task of repairing a squandered environment with diminished resources.

Thanks

Special thanks go out to all of the people who have made this book possible: Ken Layfield for his work in the early stages; Wendy Wilkins for her contributions to the water plants section; Claire Everett for her wonderful photographs; Jill Nugent, Graham Edwards, Phaedra Watts and Rod Laws for their assistance in proof reading; Chris and Kim Roycroft for use of computer hardware. Extra special thanks to Arun for all of his help in layout and production - without his help this book would have been little more than a typed manuscript. Our gratitude to Adrian for his graphics. Also many thanks to those who pre-purchased the book and told us that it was a worthwhile thing to do. A very special thanks to Chris and Kerry Harper for helping with the finances. Finally the ultimate thanks to Bill Mollison who has done so much toward making this planet a better place to live.

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How to Use this Book

The book has been categorised primarily according to the principal function of the species concerned. The PIONEERS section includes those plants whose main role is to act as nurse plants to other species, although they also have useful products and properties of their own.

The NUTS and FRUITS sections deal with species whose main product is edible, although they will usually possess other useful qualities (for example walnut also produces timber and has medicinal properties). ,

In OTHER UTILITY PLANTS, we have included all those species which do not fall easily into any of the first three sections, for example timber or animal fodder species.

UTILITY LISTS comprises lists of species which serve a particular function, such as fire retardant or bee forage species.

The last two sections, WATER PLANTS and DIFFICULT SITES, are categorised according to the particular sites the plants are adapted to.

Any method of categorising has its weaknesses and this is no exception.

This book is indexed extensively so as to facilitate cross-referencing. It is sometimes necessary to search every occurrence of a species in the book to glean all of the information about that species. This is especially true if a species makes one or more appearances in the Difficult Sites section of the book. A good way of checking a plant function or product is to search it in the index, it should then navigate you to this information.

"Diameter" refers to trunk diameter unless otherwise stated. "Width" or "spread" refers to diameter of canopy.

Geographical references which are unspecified refer to Australia.

INTRODUCTION

It is not the purpose of this book to cover the vast topic of Permaculture. Rather it is a resource list that we hope will help Permaculture practitioners with their efforts. Included in thus book is a quick overview of Permaculture so that the novice can see the big picture.

In the late 70's and early 80's the species lists in "Permaculture 1" by Bill Mollison and David Holmgren (Tagari Publications), was all that we had as easily accessible tools in our design work. The rest was a matter of wading through volumes of material and wishing it was already compiled. Little has changed in the late 90's except there are more texts available to wade through. It is hoped that this book will help to reduce the wading, allowing more time for planning and planting.

At no time in the history of the planet has there been such a great opportunity to shift species around the planet. International flight means that even those seeds which lose viability very quickly can be transported. There is of course a need for some care in selecting which species do get introduced. It is important to monitor their progress before widespread introduction to an area, but ultimately most species are complete unknowns in a different environment until they are trialed there. Certain species are prohibited imports into some countries because of their status as rampant weeds.

There is a major global move toward prohibiting the importation of species. This movement seems to be prompted by multi-national companies who perceive that Permaculture could interfere with their command over the planet. That command is now all but complete as every country on the planet faces bankruptcy and is selling off the last of their assets to balance the books.

This movement to suppress species shift is supported by a sector of the environmental movement. The catch cry is "invasive species", yet most invasive species (perhaps with the exception of *Homo sapiens)* are only growing in badly damaged ecosystems and are usually doing a valuable job holding the soil together.

This is very true of the tagasaste in Western Australia. In some parts of the foothills surrounding Perth it is stepping into bushland. This bush has been so badly abused over the last 160 years of European setdement that it has lost its integrity as a complete ecosystem. Tagasaste is a saviour to that system, shading exposed soil and adding nitrogen to the system, but is misinterpreted by some as an invader. Ecosystems are not fixed, but dynamic. It is fortunate that we have the diversity of species from around the world to get us through these times of rapid change and decline of ecosystems.

As far as we know every species is native to the planet Earth. Every species tries to extend its boundaries as far as it possibly can. The Australian Aboriginal has been in Australia for, at the most, 100 thousand years. Is the Australian Aboriginal native to Australia? The whole question of what is native needs consideration. This book only uses the expression "native" as a guide so that the reader can grasp the origin of a plant and hopefully make some informed decision on the kind of climate that it may be suited to.

We are losing species on this planet faster than they are being catalogued, as the industrial world exploits the last corners of the planet and the last wilderness is lost. We are also losing the information that indigenous peoples had on how these species could be utilised. Perhaps the only chance of saving many of the species is to grow them in our own systems. Indeed many of our domesticated fruits are now unknown in the wild.

This book is really about conservation - conservation of soil, fossil fuel, human energy, species and genotypes of species. Ultimately it is about conservation of the human species which is obviously doomed unless we change our priorities and shift our direction towards well designed sustainable systems.

OVERVIEW OF PERMACULTURE

It is strongly recommended that those unfamiliar with Permaculture seek out and study "Introduction to Permaculture" and "Permaculture: A Designers Manual", both by Bill Mollison (Tagari Publications).

Permaculture Species

Compare the array of plants and animals available to us, with modern agriculture, where single species are grown to the absolute exclusion of anything else and over vast expanses of land.

There are about 15,000 plants recorded in the literature as edible. It seems likely that there are many more still unrecorded. There are also the plants that feed us indirectly. Flowers produce nectar from which our bees make honey. Legumes, grasses and trees feed our animals to give us meat, eggs, milk and so on. Other species of plants provide us with medicines, dyes, fibres, timber, fuel, fences, windbreak and shelterbelt. Some plants fix atmospheric nitrogen and others suppress fire.

"The tool with the greatest potential for feeding men and animals, for regenerating the soil, for restoring water systems, for controlling floods and droughts, for creating more benevolent micro-climates and more comfortable and stimulating living conditions for humanity is the tree." - J. Sholto Douglas et al, "Forest Fanning" (Robinson & Watkins Books, 1981)

Design Principles

The greatest criticism of Permaculture the authors have ever heard, is that it is "just common sense really". Permaculture is common sense, but the thing that separates it from other methods of providing human needs is design. The design is based on observations we have made of patterns of natural ecosystems and how they function. In our planned ecosystems of useful plants and animals, different plants and animals in the system contribute to the integrity of the whole and all benefit from it. Monoculture with its associated destruction of the soil, its heavy demands for energy and use of chemicals becomes redundant.

There are a few fundamental principles which must be taken into account. Every element in a system should serve many functions. Every function should be supported by many elements. Every action we make should achieve many results.

When designing a property, first consider the **house site(s).** These are determined by **sun facing slopes** in cooler climates, **gravity fed water** (where possible), **economical access** and **site repair** (with everything else equal, it is better to build a house on a site that is degraded and enhance it than to select a beautiful site and destroy it).

Once the house(s) is placed we can draw several overlays onto a map of the property. The first is **zones,** which can be easily summed up by the rule of thumb **oftenest is nearest.** By this we mean that the things that we visit most often are placed nearest to the house(s). The benefits of this approach to the occupier(s) of the house should be obvious. The **home garden** and grafted fruit trees are near the **centre of activity** where they get the maximum attention and where the harvests are close to the kitchen. The **fruit forests** and **animal forage systems** are placed further away as they do not need visiting very often. Through this whole system can be woven a **multi-purpose walk** which takes in all the daily chores in one passing. Things needing most attention are placed closest to the multi-purpose walk.

The second overlay **(sectors)** looks at blocking, directing and even harvesting natural energies entering the system. Cold winter winds are blocked, cool summer winds are encouraged, hot summer sun can be screened from some elements such as the house and shade loving plants, whilst the winter sun is allowed to penetrate deep into the system.

The interface between two ecosystems such as land and lake, forest and grassland, or ocean and land is always much richer in species than either of the two systems. These edges are habitat to species from both ecosystems but also to a range of species quite specific to that edge. We can use this **edge effect** in our designs so as to maximise the productivity of a system.

In nature we see **stacking** of plants where different species occupy every level of a forest or woodland. It is possible with careful planning to arrange a stacked ecosystem of plants, all or most of which are in some way benefitting the whole and providing us with products.

In the south west of Western Australia, as with many parts of the world, we are especially aware of increasing ultraviolet radiation levels. The effects on plants are not well known. Early research suggests that mature plants have a better chance of survival. Plants from the highland tropics are already adapted to higher ultraviolet radiation levels.

The effects on human health of increased ultraviolet radiations are well documented and include increases in skin cancer, cataracts on eyes and general breakdown of the immune system. We try to avoid long periods of exposure to the sun by wearing protective clothing. Patterns in our property designs can also help to protect us from too much exposure.

Shaded Walks: Roads and pathways are vital to our systems if we are to travel efficiently to different parts. We often find ourselves having to move around outside in the heat of the day, when ultra violet radiations are potentially at their worst.

Starting with the most used walkways establish trellis and large shade trees over these paths and roads.

The most frequently used sections of the multi-purpose walk, for example the path to the chook (chicken in America and hen in England) roost, can be trellisedwith a mixture of deciduous and evergreen vines.

By arranging a balance of deciduous and evergreen shade plants it is possible to provide a warm place to sit on cool winter days.

Shaded Play: Keeping children out of the sun is as difficult as keeping a hat on a child. It therefore makes sense to arrange the system so that those places where children are attracted are shaded.

The **adventure playground** should be sited in such a way that it attracts children out of the sun as much as possible. Play ground equipment such as trampolines, slides etc. can be spaced along the shaded multipurpose walk. Often these apparatus can be a goal along the walk.

The Selection of Species

Naturally not all species will suit a particular site. Although we are usually engaged in maximising the products and functions of a plant, the primary concern when fitting a species into a system is to ensure that its needs will be met. Each plant needs optimum conditions so as to give optimum production. There are exceptions to this, for example a cork oak growing on dry, rocky outcrops produces a superior cork to one growing in more ideal conditions.

Plants can be placed into micro-climates so as to accommodate their special requirements. These microclimates can optimise aspect, slope and shelter. Soil types are also a consideration. Natural rainfall of a site is not always optimum for a particular species. Irrigation may be necessary or alternatively plants may need to be placed on well drained slopes so as not to become waterlogged by greater rainfalls than they would normally receive.

Given that the global climate is changing, it is also reasonable to include species which will survive the current climate but which may excel if the climate shifts in a given direction.

Accessing Plants

Identifying the best species for a situation is only part of the process. Availability of species also has to be considered. A great aid to locating seed source for many of the species is "Cornucopia - A Sourcebook of Edible Plants", by Stephen Facciola (Kampong Publications 1990).

We are also still trying to access some of the species in the book *(Derris indica* and the almost extinct *Parajubaea brallyi* are two species which we feel have great potential in the Western Australian wheatbelt, but which have so far not been accessible to us).

PROPAGATING PLANTS

Seeds

The cheapest and sometimes the only way of accessing a species is by seed. Plants propagated by seed are generally variable and it may become necessary to plant a lot of seeds and select the best specimens from these to propagate from. This can be done through selective breeding or by vegetative propagation such as cuttings. Grafting or budding of select plant material is also an option.

All species have some mechanism for delaying germination until the seed has dispersed. Some species are simple and others more complex to germinate. Norman C. Deno, 139 Lenor Drive, State College PA 16801, USA, has authored and can supply a very comprehensive book on this science.

For the purposes of this book scarification with boiling water is described under carobs but can also refer to filing away the hard case of some larger seeds. Stratification means placing seed in a medium and exposing it to freeze conditions, usually in a refrigerator, for a month or more.

We have developed a couple of strategies for germinating seed. The preferred medium is a sterile peat moss or more environmentally friendly is the coconut moss made from coconut fibre. This medium should be barely damp. It should not be possible to squeeze any free moisture from a handful. All seed should be free of fruit and other contaminants so as to avoid feeding pathogens.

Larger seeds can be soaked overnight in warm water and kept in a warm position in sufficient medium to prevent them from drying out. Sealed plastic bags keep the moisture level constant. When germination begins the seed can be gently planted into pots or direct sown into the ground. Remember that some species, especially the palms, may require a year or more to germinate. Seeds in pots tend to become forgotten, dry out or become strangled with weeds before they ever get a chance to germinate. Using this approach we can ensure that all seed in pots has at least germinated before the maintenance effort begins.

The problem with small seed in conventional seed flats is that the medium can easily dry out or become watedogged from over watering, and in both instances it will not germinate. Attempts to use the plastic bag method for smaller seed results in seed germinating which is very fiddly to plant out. Sealed plastic containers marketed in Australia with yoghurt or ice cream in them, can be half filled with medium and then sown to the small seed. The lid is sealed to contain the moisture and the container placed in a warm position where daylight strikes the container. They are then free to germinate and grow until they reach a manageable size for transplanting to pots or into the ground.

Cuttings

Many species are able to grow from cuttings. In some cases the root systems do not develop as well as do seedlings. Root hormone can be purchased to encourage the formation of roots or it can be derived naturally from willows (see section on willows).

Some advanced methods of propagation by cutting are layering and aerial layering. Small slits are made into the bark of a plant's stem and that stem of the plant is either laid into a trench and covered with soil (layering) or the stem is surrounded by medium and wrapped with plastic (aerial layering). Once the plant has taken root, it can be removed from the parent.

Suckers

Many species form suckers and these can usually be cut from the parent tree and planted out.

THE PIONEERS

The pattern we observe in nature as forest steps out into grassland is an important one. It is a pattern which we can apply directly to the systems that we are designing.

On the edge of grassland and forest there exists a set of species we call pioneers. These pioneers are usually nitrogen fixing. They are usually fast growing and often short lived. They are generally very variable and produce an abundance of seed (more often than not this is a good poultry forage). This seed is usually dispersed by animals and requires scarification to germinate. Scarification can be in the form of passing through the digestive tract of an animal or by being exposed to fire. We can scarify seed, where necessary, by soaking in boiling hot water or filing the hard seed cases.

The pioneers are able to withstand the hostile conditions often imposed on young trees. They act as nurse trees and provide an ideal growing environment for the longer term trees. For example, they provide shade and shelter, crowd out grasses and provide mulch from leaf litter. As the longer term trees grow, they often crowd out the pioneers which can then become a minor part of the system, if they remain at all.

We can simulate this **succession** by planting out pioneers on to bare or pastured areas and streamline the reclamation process. The longer term trees that we choose will become the succession species.

Other pioneers not mentioned here would include: *Cassia spp, Gytisus spp* and *Prosopis spp.* The latter are all banned from import into Australia because some species become rampant and have thorns.

TAGASASTE *(Chamaecytisus palmensis)*

Family: FABACEAE/PAPILIONACEAE

Tagasaste or tree lucerne as it is also known, is a nitrogen fixing legume native to the Canary Islands and is one of our most useful pioneer species. It is generally fairly short lived, although regular cutting or browsing can considerably extend its life expectancy. Today, it is a naturalised coloniser of Australian wastelands capable of surviving on a wide range of soils. In Western Australia 50,000 ha of mostly marginal farmland has been planted to tagasaste (by 1996). It is estimated that 1.5 million ha of Australian farms could benefit from tagasaste.

It grows to a height of up to 7 m and is capable of productive growth in areas of low rainfall (300 mm). Drought tolerance is improved if phosphorous is readily available. Liberal application of rock phosphate at planting time works well. The nitrogen fixing bacteria does not generally need introduction with the plant as it is usually present in the soil from other species including *Acacia spp, Albizia spp, Cassia spp, etc.*

Tagasaste is a fast growing, highly productive stock feed with high nutrition levels, low toxicity and a high degree of palatability.

Comparison of Tagasaste Foliage with Other Common Stock Feeds

Composition expressed as a percentage of the dry matter
(Based on Snook 1986)

Constituents	tagasaste	lucerne	rye grass	wheat grain	field pea seed
Crude Protein	17-31	21	16	11	26
Carbohydrate	38-58	40	46	82	63
Crude Fat	2-6	3	4	2	1
Crude Fibre	14-30	26	24	3	7
Total Ash	4- 10	10	10	2	3
Calcium as Ca	0.48- 1.62	2.2	1.0	0.04	0.24
Phos. as P	0.12-0.41	0.33	0.26	0.24	0.24

In early work at the Martindale Research Project at New Norcia in Western Australia, on near useless sandy soils, capable of yielding only 700 kg of wheat, tagasaste has yielded the feed equivalent of 1100 kg of wheat. The researchers also found that the ovulation rate and the twinning rate of ewes on the tagasaste was significantly higher than their flock mates on dry pasture or a lupin stubble. 45 ha of tagasaste in rotation, easily fed 650 ewes (in lamb) for 56 days over summer, increasing the average live weight from 51 to 52 kgs. This area recovered before further rainfall.

Martindale's trials have established that ewes on tagasaste over summer/autumn grew 30% more wool, with the same yield, but slightly broader micron, compared with their traditionally managed flock mates.

Dandaragan farmer John Cook has claimed that tagasaste can lift profit from $6/ha to $30/ha in his area.

To maximise the stock feed potential of tagasaste, the trees should be trimmed at a very early age so that they tend to bush rather than become erect trees. This keeps the habit low so that stock can reach the foliage and ring barking is virtually impossible. Ideally these trees are arranged into lock - up fodder systems to allow the trees time to recover from grazing and to avoid the time consuming cut and carry method. Well fenced hedge rows can be constantly grazed.

Stock Carrying Capacity of Tagasate Compared to Pasture

(Based on Snook, for Margaret River, W.A. Planting density - 1000/ha)

YEAR	1	2	3	4	5	6
Tagasaste						
Edible yield/ha/yr						
(tonnes dry matter)	-	2.7	5.4	9.4	16	19
Pasture						
Edible yield/ha/yr						
(tonnes dry matter)	5.5	5.5	4.0	2.0	1.0	1.0
Stocking Rate						
Sheep/ha						
Tagasaste Only	-	5	10	17	29	35
Tagasaste & Pasture	10	15	17	21	31	37

Tagasaste is also a valuable source of feed for bees and it flowers in the winter, a time when little else flowers. Cutting different plants at different times can significantly extend the flowering period of a stand of tagasaste. It is a prolific producer of seed which is valuable as a free - range chicken forage. Poultry gain benefit from tagasaste leaves as a source of greens. Tagasaste is readily eaten by other types of stock, such as pigs, horses and rabbits, and can comprise a major portion of their diet. Rabbits in the Canary Islands, reared on tagasaste, are said to produce exceptionally tasty meat.

Comparison of Tagasaste Seed with Other Poulry Feeds.

Composition expressed as a percentage of the dry matter (Based on Snook 1986)

Constituents	tagasaste seed	oat grain	wheat grain	field pea seed
Crude Protein	25	10	11	26
Carbohydrate	54	69	82	63
Crude Fat	12	4	2	1
Crude Fibre	6	13	3	7
Total Ash	3	4	2	3
Calcium as Ca	0.07	0.06	0.04	0.24
Phos. as P	0.40	0.14	0.24	0.24

Tagasaste can be used as a nurse crop for other trees. In trials conducted in New Zealand with various fruit and nut trees, it was found that trees growing in close association with tagasaste (as close as 1 m) consistently grew better than the controls without tagasaste.

When tagasaste is grown this close to other trees it may influence the tree's shape. If a tree is grown for timber, then the tagasaste will tend to force the tree up for light, and provided it is surrounded with tagasaste, it should produce a good straight, long timber tree. If the nursed tree is required to produce fruit or nuts then a spreading habit is usually desired, to allow easy access to fruit. In this case the tagasaste should be clipped and used as a mulch around the nursed tree or fed out to stock if necessary.

The wood is a good firewood and has potential as a hard, light wood for tool handles and craft work.

TREE LUPIN *(Lupinus arboreus)*

Family: FABACEAE/PAPILIONACEAE

The tree lupin is an evergreen, perennial shrub or small tree to a height of about 2 m. It is native to California. This attractive plant is nitrogen fixing and a good nurse crop. It is tolerant of frost and does better with some summer watering. It prefers a deep loose soil. In the UK it has become a volunteer of limestone quarries.

It is a good bee forage, flowering from late winter to early summer. A second flowering occurs in the autumn. No data is available on its value as a stock feed but it is likely that it is too toxic. Hungry kangaroos will not eat it which is an advantage in many situations. It can be cut hard to supply mulch rich in nitrogen.

It can be grown from cuttings but growing from seed is easy.

WATTLES *(Acacia spp)*

Family: MIMOSACEAE

A large genus including some 850 species native to Australia. The seed of some species is edible and some species are traditional (bods of the Australian Aboriginal. The seed is generally a good poultry fodder. They are usually a good source of pollen but not of nectar. Most species are smaller plants and the wood is only significant for fuel, craft uses, fence posts and mine timbers, but some are more significant and are prime furniture timbers.

Acacia adsurgens (mintilpi)

A moderately fast growing, large shrub to shrubby tree. Grows in hot dry zones on well drained, infertile, acidic and neutral sands and loams, altitude 100 - 700 m, and rainfall 100-550 mm. Palatable to cattle but not grazed to any great extent. Good potential for fuel and soil stabilisation.

Acacia ampliceps (salt wattle, jila jila)

A large dense shrub or small tree, (2-8 m), for warm to hot, semi - arid to arid tropical areas (rainfall 250 - 700 mm). Fast growing and tolerates alkaline, highly saline and waterlogged conditions. Timber is good as fuel and has some potential for posts and small poles. A very hard and tough wood it may have craft wood potential. It is heavily grazed by cattle.

Acacia aneura (mulga)

This outstanding fodder tree is native to all states of Australia except Victoria and Tasmania and survives annual rainfalls between 200 - 500 mm. Some trees are straight trunked (to 9 m) while those growing in extreme conditions remain a shrub. It prefers red clayey loams or red sands for best growth but will survive most soil types. It can withstand some frost.

A daily ration of 1.4 kg of mulga leaf supplies sheep with sufficient protein (12%), calcium and vitamin A. The mulga diet needs supplementing with foods containing sulphur and phosphorous.

The wood has striking colour and is used as a craft wood. It turns well and takes a high polish. It is one of the hardest woods in the world and is used for fence posts, mine timbers and other structural posts. It is a useful firewood that burns quickly and leaves no coals.

In the wild it grows as a companion to *Eucalyptus spp,* other *Acacia spp, Atriplex spp Maireana spp, Eragrostis spp, Triodia spp and Aristidia spp.*

Acacia baileyana (cootamundra wattle)

A shrub or small tree (to 5 m and as wide) with fine misty blue foliage. A short trunk and rounded canopy. Flowering time June - September. Does not favour limestone. Fast growing and generally short lived. (Shortening of branches after flowering can prolong the life of the tree). Prefers higher rainfall areas and is both frost and reasonably drought tolerant.

Widely planted as a shade or shelter tree. The tree burns readily in fire but usually recovers. The seed is a good poultry feed.

Acacia bivenosa (two - veined acacia)

A moderately fast growing, spreading shrub 1.5 - 2.5 m tall, occasionally attaining 4 m with a 6 m spread. It is widely occurring in the hot arid zones of north western Australia, at altitudes ranging from 0 - 500 m and rainfall from 60 - 650 mm. *Acacia bivenosa* grows in a variety of locations, but is *most* often found in well drained situations on neutral to alkaline, less fertile soils, and has potential for stabilising sandy soils. As a stock feed it appears to have a low palatability to both cattle and sheep. The wood is pale, sometimes with a core of dark brown heartwood, moderately dense and should make a useful fuel. The main potential for *Acacia bivenosa* seems to be for sand stabilisation, soil protection and low shelter. Plants coppice well.

Acacia chisholmii (Chisholm's minni ritchi)

A moderately fast growing, spreading shrub, 2 - 3 m tall. Grows on harsh, rocky soils in hot, subtropical and tropical semi - arid zones, altitude 10 - 450 m, rainfall 190 - 800 mm. May have some fodder value, and has potential for fuel, low shelter and soil stabilisation.

Acacia cuspidifolia (spine - tipped wattle)

A moderately fast growing, dense, bushy, large shrub to small tree growing to a height of 2.5 - 4 m and 4 - 6 m across. It is native to the hot, arid zone in the central - western part of Western Australia. Rainfall 75 - 235 mm. It grows in calcareous, reddish sandy loams, clays and stony, red clay loams. It is a good choice for difficult sites as it tolerates saline, alkaline and stony, compacted soils. Grows in association with *Acacia victoriae, Acacia sclerosperma, Acacia ligulata, Acacia sibilans, Acacia tetragonophylla* and *Acacia galeata.* It appears to have some potential for fodder, as it makes strong regrowth after heavy grazing in its native state. The wood is suitable as firewood. The trunk and larger branches may reach sufficient size for conversion to charcoal. *Acacia cuspidifolia* has excellent potential for shelter and soil protection! Protection of young plants from grazing animals is essential. It has some ability to coppice.

Acacia cyclops (coastal wattle)

A dense, bushy, rounded, spreading shrub (2-4 m), native to SW Australia. Flowers in summer. Rainfall 200 - 800 mm on shallow calcareous soils. Tolerant of saline and waterlogged soils.

It has the ability to withstand wind and salt spray and is useful in soil stabilisation. It has fire retardant properties.

In South Africa the tree was used to stabilise sand dunes and is now spreading. It has become a popular firewood which is dense and of a high quality. Goats and antelopes browse the phyllodes and the seeds are eaten by birds, primates, and rodents.

Acacia dealbata (silver wattle)

A fast growing, nitrogen fixing tree (25 - 28 m), within open forest or tall open forest and as a small shrub on sandstone ridges. Rainfall varies between 600 - 1000 mm at altitudes from 50 - 1000 m, in its native area in the south east of Australia.

Its native companions include: *Eucalyptus fastigata, Eucalyptus regnans, Eucalyptus delegatensis, Eucalyptus viminalis, Eucalyptus radiata, Eucalyptus dives* and *Eucalyptus nortonii.* It regenerates quickly after clearing or a fire, as it suckers profusely. The wood is used for pulp production in Victoria and Tasmania and has good glueing properties. Other uses include clothes pegs, wood wool and shoe heels. It is not considered a good fire wood.

Acacia decurrens (green wattle, Sydney black wattle)

A fast growing coloniser of damaged areas, this native of the south east of Australia grows to 9 m in height and 5 m wide in rainfalls of 700 - 2600 mm, and has been established in altitudes up to 2500 m. The tree spreads rapidly by seed and root suckers, forming stands too dense to

permit grasses to grow. It regenerates after coppicing. The wood is used for building poles, mine timbers, fence posts, hardboard and has considerable potential for fine wood crafts. It is a good windbreak species and an excellent pioneer into pastured land. The bark can be used in tanning.

Acacia glandulicarpa (hairy pod wattle)

A dense, rounded, spreading shrub (to 2 m) with sticky leaves. Rainfall 400 - 500. mm. Flowers from July to October. It has fire retardant properties and does best in open conditions.

Acacia harpophylia (brigalow, spearwood)

A 12 - 24 m tree which forms suckers and is tolerant of heavy clay soils, often highly alkaline or saline. It is native to semi - tropical and warm temperate areas of eastern Australia, at altitudes of 120 - 330 m and rainfall of 300 - 750 mm. The wood is hard, heavy, elastic and strong, ideal as fuel (good charcoal), posts, poles and gives a fine finish for turnery and cabinet making. It splits easily and the heartwood resists decay and termites. A good tree for shade, shelter and is an attractive ornamental. Naturally occurring companions include: *Eucalyptus cambageana, Eucalyptus populnea, Eucalyptus microtheca, Acacia cambagei, Acacia excelsa, Acacia pendula, Casuarina cristata, Terminalia oblongata, Brachytiton rupestris, Geijera parviflora* and *Helerodendrum diversifolium.*

Acacia iteaphyiia (Gawler Range wattle, Flinders Range wattle)

A tall shrub (2-4 m), with a single short trunk or dividing near the ground into a few main stems. Rainfall 200 - 500 mm. It grows well in coastal through to inland areas, on compact and shallow soils and can tolerate extreme heat. Flowers from late winter to early spring. In cultivation it responds well to watering but requires well drained conditions. It is fast growing and has fire retardant properties.

Acacia ligulata (sandhill wattle)

A fast growing, bushy, rounded or spreading shrub, (1 -5m), with extensive occurrence in the arid country of Australia, rainfall 110 - 250 mm, altitudes near sea level to 700 m. It grows on an extensive range of soil types, especially sands and loamy sands that are calcareous, although it is not restricted to these areas. It is moderately salt tolerant and occurs on the edges of saline depressions. The leaves have a moderate protein and a low fibre content, and are eaten by cattle, but are not palatable to sheep.

Acacia lysiphtoia (murlurpa, wirilig, minni ritchi)

A moderately fast growing, spreading shrub, 2 - 5 m tall. Grows in hot, semi - arid parts of the tropics and subtropics, altitude 10 - 525 m, rainfall 125 - 600 mm, on a diverse range of soils, particularly infertile soils. It has low palatability to stock and moderate nutritive value, but good potential for fuel and soil stabilisation on infertile sands and lithosols.

Acacia maconochieana (mullan wattle)

A small, erect, moderately fast growing tree, to 12 m tall. Occurs in hot, semi - arid zones, mainly on low lying areas in the central - western part of the Northern Territory and adjacent part of Western Australia, altitude 250 - 400 m, rainfall 270 - 400 mm. The species is highly tolerant of salt and waterlogging stresses, and is found on loams, clay with a thin covering of sand and stony heavy clays. It usually occurs in monospecific stands of low open forest and woodland, but is also found in association with *Acacia stenophylla* and *Melaleuca uncinata.* It has potential for fodder, firewood and small, round timber production. It appears to have a high palatability to cattle, with digestibility of 41% and a protein level of 12%. The timber is heavy with a broad band of yellowish sapwood which contrasts sharply with the dark brown heartwood. An excellent firewood, with upper calorific value of 19.4 MJ/kg, but leaves a lot of ash.

Acacia mearnsii (black wattle)

A fast growing, nitrogen fixing tree to 6 - 10 m. It is adapted to a wide range of sites receiving 600 - 925 mm rainfall and at altitudes from near sea - level to 200 m. Native to south - eastern Australia.

Black wattle occurs in the understorey of tall, open forest dominated by eucalypts. It can form dense thickets where it has recolonised cleared land. Its native companions include *Eucalyptus saligna, Eucalyptus bosistoana, Eucalyptus muellerana, Eucalyptus ovata, Eucalyptus globulus, Eucalyptus viminalis, Eucalyptus cypellocarpa, Eucalyptus radiata* and *Eucalyptus smithii.*

The leaves have a high protein content (15%) but palatability trials with sheep showed milled leaves to be unpalatable on their own. It has been fed to cattle in Hawaii in drought periods. It is an efficient nitrogen fixer and is an ideal tree for regenerating impoverished soils. In Indonesia where the tree is used extensively, it is found to yield 21 - 28 t/ha/yr of wet leaves, containing 240 - 285 kg of nitrogen. Indonesian farmers claim that vegetables and tobacco grown in rotation with *A. mearnsii* give twice the yield because of the green manure the trees provide.

It yields high quality tannin (36 - 44%) from the bark; the powdered bark extract is used to prepare tannin formaldehyde adhesives for exterior grade plywood, particle board and timber.

The wood is hard, but is moderately easy to work, and takes a good polish. The wood is used for house poles, mine timbers, tool handles, cabinet making, joinery, flooring, construction timber, matchwood and hardboard. It is used for rayon pulp arid paper pulp, although the hard wood makes chipping expensive. It has good strength characteristics for wrapping paper, and is an excellent fuel wood and charcoal.

It is cultivated in India, South Africa, eastern Africa and South America. South African plantations cover 160,000 hectares, and there are over 125,000 hectares in Brazil. This acacia is probably the best example of an Australian tree which is used extensively overseas but almost ignored in its homeland.

Acacia melanoxylon (blackwood)

A reasonably fast growing, nitrogen fixing tree, attaining heights of 35 m and trunk diameters of up to 1.5 m in ideal conditions, in the lowlands of Tasmania. It occurs naturally in eastern Australia in conditions ranging from lowland swamps to higher hill slopes and tablelands and even exposed mountain tops, in areas receiving average rainfalls from 750 - 1500 mm. Altitudes range from near sea level to 1500 m.

As a large tree it grows as understorey to *Eucalyptus regnans, Eucalyptus obliqua, Eucalyptus viminalis, Nothofagus cunninghamii* and *Nothofagus moorei* In areas of open forest, it grows as a smaller tree and in mountain heath it is a small shrub. Blackwood has the ability to coppice and to form root suckers.

The timber is generally easily worked, turns well, has a sheen and dresses to a smooth finish which takes a high polish and is well suited to high quality furniture and cabinet making. It is also regarded as a good bending timber. It is not a good fire wood.

Blackwood is considered slightly salt tolerant.

Acacia pendula (weeping myali, boree)

A relatively slow growing tree native to the eastern states of Australia (rainfall 400 - 650 mm; altitude 90 - 350 m) and grows from 6 - 12 m. It prefers good clay or black soil and access to groundwater.
It is eaten readily by sheep and cattle and is thought to be more palatable and nutritious than mulga *(Acacia aneura).* The heartwood is heavy, hard, close grained and dark brown, and is suited to turnery and craft wood. It is used for fence posts and is also an excellent firewood. It often forms pure stands on heavy soils adjacent to watercourses but also grows as a companion to: *Acacia cambagei, Acacia harpophylla, Acacia salicina, Acacia stenophylla, Acacia omalophylla, Atalaya hemiglauca, Atriplex nummularia, Cassia spp, Casuarina cristata, Eremophila spp, Eucalyptus largiflorens; Eucalyptus melanophloia, Eucalyptus microtheca, Eucalyptus orgadophila, Eucalyptus populnea, Eucalyptus woollsiana* and *Flindersia maculosa.*

Acacia ramuiosa (horse mulga)

Native to all states of Australia except Victoria and Tasmania, growing to 2 - 6 m high and the same or more across. It is very drought tolerant (150 - 200 mm minimum rainfall), and has moderate palatability and nutritive value. Useful for windbreak on sandy and calcareous soils having a moderate to fast growth rate. Companions include *Acacia aneura* and *Casuarina cristata.*

Acacia saligna syn. Acacia cyanophylla (golden wreath wattle, western wattle)

Grows as a dense, bushy shrub or small tree ranging in height from 3 - 8 m. This fast growing, fire retardant, salt tolerant legume is native to the south west of Western Australia, and is able to withstand rainfalls as low as 300 mm. It is well known in cultivation as a valuable hardy ornamental or small shade tree. It occurs in both a suckering and a non - suckering form. The leaves are palatable to livestock when fresh or dried into hay, although have a low digestibility. The damaged bark exudes large amounts of very acidic gum which shows exceptional promise for use in pickles and other foodstuffs. It is suitable for soil stabilisation and does well in sand near coastal areas. The suckering variety readily forms thickets, and it is ideal for low windbreak and erosion control. Companions include *Eucalyptus drepanophylla, Eucalyptus crebra, Eucalyptus melanophloia, Eucalyptus camaldulensis, Eucalyptus tereticornis, Eucalyptus moluccana, Acacia harpophylla* and *Acacia cambagei.*

Acacia salicina (cooba)

A tall, vigorous shrub or tree (to 20 m), on flood plains on most soils, including alkaline and saline. The leaves and pods are readily eaten by sheep, although high tannin levels in the leaves have been suspected of poisoning hungry cattle. It has been planted with other acacia species in the arid zone of Libya. The wood is tough with an attractive grain and takes a high polish, rivaling the blackwood.

Acacia sclerosperma (large seeded cooba)

A moderately fast growing, multistemmed, large shrub 1.5 - 2.5 m tall and 3 - 5 m across, occasionally reaching 6 m tall with a spread of 8 m. It is a common species in the hot arid and semi - arid zones of central - western and north - western Western Australia, altitude 0 - 500 m, rainfall 50-325 mm. It grows in a wide variety of soils, but typically it is associated with drainage lines or rock outcrops, on alkaline and sometimes saline soils. It also occurs on coastal dunes, sandplains and a variety of hard and/or stony soils. Common associates of *Acacia sclerosperma* include *Acacia victoriae, Acacia tetragonophylla, Eucalyptus camaldulensis, Eucalyptus microtheca, Eucalyptus striaticalyx* and *Casuarina obesa.* Its main potential appears to be for stabilisation of sandy soils and low windbreak which may be further enhanced by coppice. Tolerant of coastal salt spray.

Acacia sibilans (whispering myall)

A very hardy, large, slow growing shrub or small tree, 3 - 6 m tall, with round - crowned to spreading habit. Under favourable conditions it may grow as large as 12 m tall and 15 m across. It occurs naturally in the warm to very hot and arid zones in the central - western part of Western Australia, altitude 10 - 500 m and rainfall of 95 - 230 mm. Grows on sands and loams, including saline, calcareous types. Has potential for soil stabilisation on calcareous and saline soils.

Acacia stenophylla (river cooba)

A vigorous, nitrogen fixing small tree (4 - 10 m) adapted to saline and alkaline, heavy clay soils in arid and semi - arid areas of central and eastern Australia, with rainfalls from 125 - 600 mm and altitudes from 50 - 325 m. It is palatable to sheep and could be used as a reserve fodder. It produces a very hard timber, which is heavy, close grained, dark, reddish brown to almost black, beautifully marked and is suitable for furniture. It is useful also as fence posts and is an excellent firewood. The seed was roasted and eaten by the Aborigines. A good ornamental and windbreak. Although it can form pure stands along water courses, its natural companions include: *Eucalyptus camaldulensis, Eucalyptus microtheca, Eucalyptus largiflorens, Eucalyptus populnea, Acacia salicina, Acacia pendula* and *Casuarina cristala.*

Acacia stipuligera (tjilpirinpa, kutaiaan)

A moderately fast growing shrub of the hot, semi - arid tropical and subtropical zones, altitude 0 - 525 m, rainfall 150 - 600 mm. Uses limited to fuel and sand stabilisation.

Acacia victoriae (gundabluey, narran, prickly wattle)

A short - lived (10-15 years), moderately fast growing shrub or small tree (1-5 m), occurring throughout the Australian dry country (average annual rainfall 125 - 300 mm, but it will grow in higher rainfall areas), at altitudes from 50 - 750 m. The leaves have moderate palatability and digestibility They are a good source of protein to cattle, poultry and humans. It is a good source of pollen for bees and the twigs exude a clear, tasteless gum which seems to have outstanding use in foods and industry. The gum is often colourless - an ideal quality.

ALBIZIAS *(Albizia spp)*

Family: MIMOSACEAE

Albizia lebbek (siris tree)

A moderately fast growing, tall (to 30 m, with a trunk diameter up to 1 m), spreading, deciduous tree, native to the Indian subcontinent and requiring a rainfall of 500 - 2000 mm. The tree is good for erosion control, because of its strong root system. The trees are tolerant of salt spray and grow well near the sea shore.

The timber resembles rosewood and is a good furniture timber. The tree will coppice fairly well and is a good dense firewood. It sprouts root suckers vigorously when roots are cut or damaged.

The leaves are aromatic and used in Chinese cooking. The bark and wood are medicinal.

It is a good fodder plant, the foliage containing about 20% protein and it is alleged that one tree can provide 27% of a cows annual feed. It is also highly regarded for the light coloured honey its nectar provides.

Aibizia lophantha (crested wattle, spiked acacia)

A small, fast growing, nitrogen fixing, semi - deciduous tree or sprawling shrub, reaching a height of 4 - 15 m on favourable sites. It is a short - lived tree and is killed by fire. It occurs naturally in coastal areas of south western Western Australia, but has become naturalised in other areas of Australia, in the warm temperate and subtropical climatic zones, at altitudes of up to 200 m. The preferred average annual rainfall is 650 - 1120 mm, and it is moderately frost tolerant.

It grows mostly on soils derived from granite and also on sandy and clay soils. It is moderately drought resistant and tolerates seasonally waterlogged and infertile soils. It is also limestone tolerant and is moderately resistant to salty winds, but needs protection from winds in exposed coastal areas.

A. lophantha grows naturally in open eucalypt forest, woodland, open shrubland and also along river banks and around swampy areas. It occurs alongside *Eucalyptus cornuta, Eucalyptus lehmannii, Acacia acuminata, Agonis marginala* and *Callibris preissii.*

The fast growing capacity of *Albizia lophantha* makes it a good species for rehabilitation of sand dunes and soil stabilisation as well as for shelterbelts. Cattle browse the leaves, so it has potential as a fodder tree. The wood is soft and therefore unsuitable for fuel or constructional uses. The roots have a 10% saponin content and are utilised in silk and wood factories.

Propagation is by scarified seed.

CASUARINAS *(Casuarina spp)*

Family: CASUARINACEAE

A group of about 80 species which are primarily native to the southern hemisphere, and mostly to Australia where different species occur in virtually all climatic conditions. *Casuarina spp* form a symbiosis with a bacteria - like organism *(Frankia spp)* that infects the root hairs of casuarinas and enables them to use atmospheric nitrogen.

Casuarina wood was one of Australia's first exports, being a popular backload for convict ships. It is a hard, dense wood suited to the fine crafts industry. Casuarinas are easy to propagate, both from seed and vegetatively, and are often capable of tolerating very saline conditions. They are generally good firewood, but poor fodder plants, for which they serve only as an emergency fodder or as medicinal browse in a mixed fodder system. Although stock will graze seedlings and suckers, the foliage is high in tannin and is astringent and constipating, and may interfere with the animals ability to utilize protein. There is a place for these trees, in small numbers, within a fodder system however, as they are very hardy nitrogen fixers which should cause no problems to stock as part of a browse system.

They usually coppice well.

Casuarina cristata (black sheoak)

A shrub to small tree (4 - 16 m) native to southern central Australia. It often occurs on sandy soils over limestone or calcrete. There are two subspecies *pauper* and *crislata.* The latter is more tolerant of harsh conditions (lower rainfall down to 250 mm and saline conditions)

Casuarina cunninghamiana (river sheoak)

A medium sized to tall tree (20 - 35 m) native to eastern and northern Australia. It is the largest of the Australian casuarinas. It naturally occurs in pure stands along water courses between normal water level and flood level, in rainfalls from 500 - 1500 mm and at altitudes from sea level to 1000 m. It can also extend up rocky slopes, particularly limestone. The soils are typically gravel or sand. It is not very tolerant of soil salinity.

The foliage has been used as a drought fodder but is not high in nutrition. The wood ranges from dark red to purplish brown and is fissile, close grained, tough when seasoned, fairly durable with a density of 900 kg/cu m. The timber was once used for shingles and bullock yokes and is still used in Australia for turnery, tool handles and cask heads. It is a very good firewood.

Propagation is from seed. Seedlings are browsed by stock and need protection until beyond their reach.

Casuarina equisetifotia (horsetail tree, Australian pine, coast sheoak)

A small tree, (8-16 m), usually with a bent stem and often growing as wide as it is tall. It is usually long lived and is at home in sand dunes. Rainfall ranges from 175 - 1500 mm.

It is hardy to drought and frost but will not survive fire. It will not tolerate coppicing.

It is valuable as a windbreak species capable of absorbing heavy winds with belts of trees two or three deep. It is also valuable in erosion control along estuaries, river banks, waterways and coastal areas and is salt tolerant.

The heartwood is dark brown, very hard, very heavy (density of 1000 kg/cu m), strong and durable in the ground or submerged in saltwater. It can be used for house posts, rafters, electric poles, mine timbers, roofing shingles, tool handles, wagon wheels and for oars. It is considered one of the best firewoods (calorific value of about 4950 kcal/kg), will burn even when green and the ashes retain heat for a long period of time. It makes an exceptionally fine charcoal.

The bark, which contains 6 - 18% tannin is used extensively in Madagascar for tanning. It penetrates the hide quickly and furnishes a fairly plump, pliant and soft leather, pale reddish - brown in colour. The wood has been found to make a useful pulp.

Vanilla growers in Brazil use this tree as a companion to their crops because the soil below it seems to be always moist, supposedly from air moisture condensed on its needles and twigs.

Casuarina fraserana (Fraser's sheoak)

This small tree (to 15 m) grows mostly on sandy soils and gravels and is native to the south west of Western Australia. It occurs naturally in average rainfalls of between 900 - 1200 mm.

Natural companions include *Eucalyptus marginata* and *Eucalyptus calophylla.* It also occurs in casuarina and banksia scrubland.

It has traditionally been used for joinery, cabinet making and turnery and has great potential in the craft industry.

Casuarina huegeliana (granite sheoak)

A small tree (5 - 14 m) although sometimes as low as 2 m on adverse sites. It occurs on granitic sands, clay sands, gravelly loams and lateritic clays. Rainfalls are typically 300 - 500 mm although they can be as low as 175 mm. It has some use as a windbreak tree in conjunction with other species.

Casuarina littoralis (black sheoak)

A large shrub or small tree (3 - 12 m) growing in rainfalls between 650 - 1250 mm, although it has been recorded growing in rainfalls as low as 300 mm. It grows at altitudes from sea level up to 1200 m. It occurs in a band along eastern Australia from the tip of the Gape York Peninsula right down to Tasmania.

It is normally found on well - drained hill slopes but can also be found growing in rocky gorges, or near the edges of swamps, on heathlands and on sandy lowlands behind sand dunes. It is frost tolerant.

It is at home either as an understorey species or as a major species. Companion species include: *Eucalyptus spp, Angophora spp, Syncarpia spp,* and *Callitris spp.* It has marginal use as an emergency fodder, but is a first class fuel wood. The wood is strong, moderately durable and very fissile and was used for shingles, handles, yokes, furniture, turnery and for construction in farm buildings.

It is a good low shelter belt species.

Casuarina obesa (Western Australian swamp sheoak)

Often occupying low lying, swampy flats just above high - tide limits and along river banks and the edges of inland salt lakes. It is drought tolerant down to 200 mm. It has potential as a fine craft timber.

Casuarina stricta (drooping sheoak, coast sheoak, mountain sheoak)

A small (to 9 m) tree, usually with a short stem, but sometimes remains a small (2 - 3 m) shrub. Rainfall varies from 250 - 1000 mm. It is tolerant of frost and will grow on dry ridges, poor coastal sands, rocky ground and saline soils. It will grow in wind and salt spray affected coastal sites. It is native to South Australia, Victoria and southern New South Wales and is relatively fast growing.

It makes a good emergency fodder and the coppiced stump is reported to produce shoots vigorously. It is a tree with low fire retardant potential and generally recovers from fire. The wood is heavy, hard and fissile and is an outstanding wood for turnery. It was used for bullock yokes, wheel spokes, tool handles, staves and shingles. It is suitable for fence posts and is a good fuel wood.

Casuarina torulosa (forest sheoak, rose sheoak)

A tree to 25 m in height and 1 m in diameter. It grows on a range of soils from sandy alluvial to compact clay; from steep hillsides to undulating lowlands. Rainfall varies from 900 - 2,500 mm.

It is the only species of casuarina that is commercially sawn for construction timber in Australia, as it is not prone to splitting and checking.

ROSEWOOD (Tipuana tipu)

Family: FABACEAE/PAPILIONACEAE

Also called pride of Bolivia, this fast growing tree is native to South America. It can grow to 40 m with a spread of 6 m. The trunk can grow to 1.6 m in diameter. In warm climates it is evergreen, but will turn deciduous in cold climates.

It is a nitrogen fixing tree and is grown as nurse crop to coffee and other crops which need shade from severe heat. In Argentina, the timber is highly prized for furniture and cabinet making. It is light coloured, finely striped and takes a high polish.

LEUCAENA (Leucaena spp)

Family: MIMOSACEAE

A genus of 10 species of trees native to southern North America and Central America. The Mexican state of Oaxaca comes from the Zapotec word "uaxin" which means "the place where leucaena lives". In their native environments all species are used to some extent for fodder, fuel, fence posts and construction.

Leucaena leucocephala, syn Leucaena latisiliqua, Leucaena glauca (leucaena)

The most commercially exploited of the genus, it takes three distinct forms. The common form is a low shrub rarely exceeding 5 m which produces abundant foliage, flower and seed. The giant or Salvador type is a tall forest tree reaching over 20 m which produces little seed but the fastest bio - mass rate (varieties include: Hawaiian giants - K8, K28, El Salvador - K67). Peru type is a medium sized tree to 10 m which branches close to the ground and produces an abundance of foliage and seed.

It is fast growing (often claimed to be the fastest growing tree in the tropics) and is usually an evergreen, although it can shed its leaves in frost, storm and drought. It can withstand rainfalls as low as 250 mm but does best in rainfalls between 600 - 3,000 mm annually. It gives best growth at altitudes less than 500 m. It is able to withstand some salinity and waterlogging, although best results are achieved in deeper, well drained soils. It has been successfully grown right down to the high water mark in exposed coastal situations. It requires full sun. The plant can be killed by heavy frosts and does not grow well on acidic soils.

In the tropics, the giant form of the tree is used extensively as the classic nurse tree to crops such as cacao. The tree provides a shaded environment and the leaf drop from the leucaena is a good humus source which is rich in nitrogen. Alley cropping between rows of leucaena is used to grow crops such as corn, tobacco, yams and rice. The rows of leucaena are kept pruned so as not to rob the crops of light. Leucaena is also used to stabilise ground subject to shifting agriculture. Once a leucaena system is in place, agriculture can remain, taking the pressure off otherwise at risk forest.

The young leaves, pods and flower buds are eaten raw, steamed, in soups and stews, with rice, or mixed with chillies and spices. Unripe seeds, mixed with grated coconut and fish or meat are cooked wrapped in banana leaves. The mature, but not dried out seeds, are eaten raw or cooked. Dried seeds are made into tempeh type ferments, are also ground as a coffee substitute and are eaten as sprouts. Mimosine contents would have to be explored before these could be taken seriously as staple foods.

Leucaena is a high protein stock feed. Some of the highest stock weight gains ever recorded are attributed to leucaena. Leucaena can recover from browsing and be ready for further browsing in just two weeks. The ideal leucaena forage system incorporates a range of other species including grasses. Leucaena fed alone will result in mimosine toxicity. Ideally, leucaena should only form about 30% of the long term diet. Sheep fed for a few days on an exclusive leucaena diet suffer a fracture in their wool which makes it possible to shear them by simply pulling the wool away.

The giant types provide significant timber in short rotation. They are thin barked with a yellow - white sapwood and a yellow to reddish - brown heartwood. It has similar density and strengths (tensile, compressive, and shear) to oak, ash, birch and sugar maple. It is fine textured and easily worked. In India, a small demonstration house has been built complete with furniture and fittings from 2 year old leucaena trees. It is one of the best tropical hardwoods for paper pulp and rayon manufacture and is also used in chipboard production. The round logs can be used as fence posts, bean poles, girders, floor joists and rafters.

Leucaena is a primary energy source in many tropical communities. Plantations are harvested in a three to five year rotation. Wood from young trees has a heating value of 4,600 kcal per kg. Charcoal from leucaena has a heating value of about 7000 kcal per kg.

Leucaena stands of 10 m or more in width can suppress the spread of fire. The plants soon recover and regenerate after fire.

Leucaena esculenta (guaje)

This large tree (18 - 20 m) is native to highland Mexico. It occurs at altitudes from 1000 - 2200 m and is cold tolerant, often losing its leaves in severe cold. It is slower growing than leucaena but wood yields are high. The leaves are low in mimosine and it does not produce seed as prolifically as leucaena.

In Mexico, the Zapotec people eat the immature green bean as a vegetable. They are stripped from their pods and eaten as a side dish with salt or used in soups, salads and tortillas. They have a garlic flavour. The leaves are also edible. Some plants have a thick corky bark which may be able to be utilised.

Leucaena diversifolia

A fast growing tree native to Central America at altitudes to 2000 m. It does not grow as well in low altitudes and in hot humid climates, nor is it considered very drought tolerant. Some types are tolerant of acid soils. The leaves have a low mimosine content. The plant has a good seed yield and is a good wood producer at higher altitudes.

Leucaena macrophylla

A fast growing shrub of lowland Mexico. It grows in both wet and drought prone situations and some lines are able to tolerate acid soils. The large leaves are high in mimosine and not considered good forage.

Leucaena pulverulenta

A slow growing, tall tree of south Texas and north east Mexico. It is cold tolerant (grows naturally to 35° N latitude) and drought tolerant. The wood is very dense and makes an excellent fuel. Trials have shown that hybrids with leucaena have good form and aggressive growth rates.

Leucaena shannoni

A small, almost weeping, umbrella shaped tree or shrub of southern Mexico and Central America. It yields little seed and is not a high yielding forage plant. It is good for erosion control and protecting the soil from the sun. It is a good source of pollen for bees.

Leucaena retusa

A native of southern USA and northern Mexico, this shrub is able to endure snowy winters up to 2000 m altitude. Hybrids with leucaena are slow growing, have britde wood and require an unusual nitrogen fixing bacterium.

Leucaena lanceolata

A highly variable, heat and drought tolerant shrub of western Mexico. The leaves are large and the plant is widely used as an animal browse.

Leucaena collinsii

A native of southern Mexico, this small, elm - shaped tree is adapted to the middle altitudes (500 - 1500 m). It is fairly rapid in growth and adapted to acid soils.

Leucaena trichodes

Native to southern Panama, this slower growing, large leaved plant varies from a drought hardy shrub to a tall tree (22 m).

ALDERS *(Alnus spp)*

Family: BETULACEAE

A genus of 30 species, which, although not legumes, have the ability to fix up to 300 kg/ha/yr of nitrogen, through nodules on the roots formed by the bacteria *Schinzia alni*. The trees are mostly deciduous and many are notable softwood timber trees. Wide spaced planting of *Alnus spp* as timber has been known to increase fodder production several fold through nitrogen fixation and shelter. Inoculation of new soils will be necessary to ensure nitrogen fixation.

Alnus acuminata (aliso, ramram, labran, jaul)

A tree (15 - 40 m), native to the high altitudes of Central and South America, which can stand temperatures that dip briefly below 0°C. It has a broad and spreading root system just below the soil. The usual rainfall is 1000 - 3000 mm or more. It has been successfully established in the South Island of New Zealand. Propagation by seed.

The tree coppices and the timber is used for bridge construction and pilings, furniture, coffins, crates, plywood and pulp.

Alnus cordata (Italian alder)

A large (to 27 m), conical shaped tree, which grows rapidly on most sites, including chalk soils and dry sites. It can grow to 15 m in 20 years.

Alnus glutinosa (common alder or black alder)

Occurring naturally, throughout Europe and North Africa, this tall (to 27 m and 5 m wide) deciduous tree grows along watercourses (including rocky banks) and in wet swampy lands, and will even flourish in areas that are frequently inundated by salt or brackish water.

The leaves are eaten by horses, goats, cows and sheep, but pigs are said to refuse it.

The wood is used for waterside structures (the wood grows harder in water and becomes remarkably strong when permanently submerged and so is useful also for pumps and sluices). It has also been used for clogs, turnery, chair making, carts, spinning wheels, bowls, spoons, wooden heels, herring barrel staves and carving, and for making charcoal for use in gunpowder. The roots and knots make good material for cabinet making.

The bark is used in dyeing (red, black with coppers, yellow with a little copper, cinnamon from shoots cut in spring or tawny if dried and powdered, green from catkins, pinkish - fawn from the fresh wood) while the leaves can be used to tan leather or if spread across a floor will catch fleas on their glutinous surface.

Medicinally, a decoction of the bark is used to bathe swellings and inflammation, especially of the throat and has been known to cure ague (burning fever). Boiling the inner bark in vinegar produces a useful external wash for lice and for skin problems such as scabies and scabs. This liquid can also be used as a teeth cleaner. The fresh bark will induce vomiting, the powdered bark and the leaves have been used as an internal astringent and tonic and the bark also as an internal and external haemostatic against haemorrhage. Peasants of the Alps are reported to be frequently cured of rheumatism by being covered with bags full of the heated leaves.

Propagation is by seed in spring or by cuttings.

***Alnus incana* (gray alder)**

A deciduous tree (10 - 20 m high). Likes wet but not stagnant conditions.

Propagation is by seed, suckers and cuttings (reported difficult).

***Alnus nepalensis* (Indian alder, Nepalese alder)**

A very fast growing, large tree (to 2 m in diameter), tolerant of both shade and poorly drained soils. It requires summer - moist soils. It grows best in deep, moist, well drained loams or loamy soils of alluvial origin, but will grow on a wide range of soils from gravel to sand and clay.

The tree will coppice. The wood is fair for use in furniture.

***Alnus nitida* (Himalayan alder)**

This tall (to 35 m), tree is native to the northwestern Himalayas, where it is used for timber.

***Alnus rubra* (Oregon alder or red alder)**

A native to low - elevation, coastal, north western North America, This tall (to 40 m, with diameter up to 1 m), tree has been described as one of the most productive trees in North America (10 - 11 cu m/ha/yr, on a 20 - 30 year rotation). It is a very vigorous plant, able to cope with grasses and this combined with its nitrogen fixing ability makes it an ideal nurse crop. The wood, classed a softwood, is moderately soft, moderately light and moderately dense, with a fine, even texture. It is easy to work, does not tend to warp much during seasoning, glues easily and is popular for furniture and panelling despite the fact that it scars easily and wears poorly. It also pulps well and the pulp is used in the western USA, in a blend with conifer pulp to provide smoothness and softness to tissue, bond, envelope and book papers. The tree coppices well and makes a good charcoal.
Medicinal uses are similar to those of the common alder.

***MIRACLE PLANT* (Lespedeza bicolor)**

Family: FABACEAE/PAPILIONACEAE

A leguminous shrub to 3 m, native to Japan but widely grown in Korea for soil reclamation. The long shallow roots spread along the ground and the nodules on the roots are very efficient at nitrogen fixing. In Korea it is planted as a nurse crop to pine trees.

It is a high protein stock feed, the seeds are good poultry feed and the firewood is high quality. In Korea, yields of 2.9 tonnes of firewood per hectare in the first year are usual. It is considered a good honey plant. The leaves and roots are used in Japanese medicine.

BLACK LOCUST (Robinia pseudoacacia)

Family: FABACEAE/PAPILIONACEAE

A fast growing, nitrogen fixing legume to 25 m and living for up to 200 years. A native of the Appalachian and Ozark mountains of the United States.

The foliage is readily eaten by livestock and the seed is suitable as a poultry feed. It is a good source of nectar, producing a honey regarded as one of the finest in the world.

The timber is hard, heavy, durable, strong and very rot resistant. It is used extensively for round, hewn or split mine timbers and for fence posts, poles, railway sleepers, stakes and electrical insulator pegs.

The tree is commonly planted for erosion control, shelter belts, fodder and wildlife habitat. It coppices well and is a very good firewood which is slow to ignite but burns like coal. It is well suited to charcoal production. The plant can be a pest because of its suckering habit and thorns and should be planned into a system where it can be confined by livestock. Non - suckering cultivars are, however, available.

HONEY LOCUST (Gleditsia triacanthos)

Family: CAESALPINIACEAE

This moderately fast growing, long lived legume is native to North America and requires a rainfall of 425 - 1500 mm for good growth. It also has a good survival up to altitude 2100 m. It often attains heights of 24 m (up to 30 m), with trunk diameters of 60 - 90 cm. Its deep root system makes it capable of withstanding drought. It is tolerant of both alkaline and acid soils and also of salt. Being a deciduous tree, it allows light through in winter months, to pasture or other understorey. Mature trees are resistant to frost.

Branches generally form thorns which protect them from ring barking by stock. Some thornless cultivars do exist, although seedlings of those may revert back to thorns. Pigs, sheep, cattle and goats all readily feed on the honey locust pods which fall from the female trees in autumn.

Nutritive analysis of honey locust pods: protein - 14.3 - 16%; sugar - 15.5 - 26.5% carbohydrate - 60.5%; fat - 7.5%; calcium - 0.2%; iron - 0.0038%; nitrogen free extract - 60.8%; crude fibre - 18.4%; ash - 4.7%. They are said to be superior to oats as a stock feed. By year 12 a yield of 9 t/ha/yr can be expected at a density of 36 trees/ha, 18 t/ha/yr by year 15 and mature groves have reached yields of around 50 to 60 t/ha/yr in selected plantings in North America. The pods can also be used for human food and alcohol fuel production.

The timber is hard, heavy and strong, and the heartwood is reported to last 100 years untreated in the ground. It is a good furniture timber. The tree coppices freely and suckers from damaged roots. It is a good fuelwood.

Propagating the tree from seed is very similar to that of carob although the honey locust can also be propagated by transplanting root suckers.

ICE CREAM BEAN *(Inga spp)*

Family: MIMOSACEAE

The ice cream bean *(Inga edulis)* is an evergreen tree native to the Neo - tropics (Central and South America). It grows to a height of 18 m and a width of 4 m.

The tree has root associates which fix atmospheric nitrogen and make it available to the tree. The plant can be used as a nurse crop. It is unusual to find a nurse species with an edible bean. The beans can grow to considerable size. The white sugar - rich pulp is spooned from around the seeds of the opened bean and eaten fresh. It is said to have a sweet flavour and smooth texture not unlike that of ice cream.

In Mexico, foliage is cut and fed to livestock. In Central America and the West Indies it is used as a shade plant for coffee and cacao plantations. The tree has been used in alley cropping in Chile, and is used throughout South America as a street tree.

The timber is moderately heavy and is used for furniture, boxes and crates. The wood is not suited to external use as it breaks down quickly. It is also utilised for charcoal production.

There are more than 400 different species of *Inga* and it appears that most of them are edible although most are not conditioned to the cool extremes of the Andes. Like most plants of the Andes, the ice cream bean seems able to withstand a large range of conditions.

THE NUTS

MACADAMIA (*Macadamia spp*)

Family: PROTEACEAE

The macadamia is a small to medium, long lived, evergreen tree, which usually commences nut production between years 4 and 6. It is the first tree native to Australia which has been developed into a commercial tree crop. It is hardy to about - 4°C, although light frosts can kill new foliage which has not had a chance to harden off. Heavy frost can kill small trees and reduce yields on mature trees. It is fairly drought tolerant but will produce more reliably with irrigation. The most important watering times for a good crop are spring and early summer.

Macadamias grow best in deep, fertile, well drained soils, although they often grow on the edge of water courses where the clay is less than 100 mm from the soil surface. They do not favour acid soils, which should be treated with lime or preferably dolomite. They require no more than corrective pruning. Trees are prone to losing limbs in strong winds, so sheltered sites are recommended. They tend to produce less nuts on the windward side.

The recommended spacing of trees is 9 m x 9 m. As it is many years before the trees fill this space, a secondary crop can be grown between the macadamias. Alternatively, seedling trees can be planted much closer together and selectively thinned as their production characteristics become known. A tree aged 15 years can produce up to 40 kg of nuts.

The nuts are extremely hard shelled which renders them parrot proof. They remain fresh for a couple of years. Commercially, most nuts go to the confectionery trade but increasingly the fresh nuts are being eaten out of hand.

Nutritional composition of the macadamia per 100 grams of edible portion is: Water - 3.0%, Energy - 691 calories, Carbohydrate - 15.9 g, Fat - 71.6 g, Protein - 7.8 g, Ash - 1.7 g, Calcium - 48 mg, Potassium - 264 mg, Iron - 2.0 mg, Phosphorous - 161 mg, Thiamin - 0.34 mg, Riboflavin - 0.11 mg, Niacin - 1.3 mg.

There are now many grafted cultivars of macadamia available. A planting incorporating a selection of these cultivars and a dominance of seedlings is recommended to provide a greater cross - pollination and a more diverse crop. Adverse weather may reduce the production from a certain cultivar but not others, because of differing flowering times.

Interplanting young trees with nurse species such as tagasaste, small acacias and cassias will greatly reduce negative effects from wind. Small acacias can help to reduce the likelihood of root attack from *Phytophthora cinnamomii* which causes a trunk canker. It is advisable not to cultivate soil around macadamia trees because damaged roots are most vulnerable to this root fungus.

Propagation from seed is relatively simple. Seed is first soaked overnight in warm water. Any floating nuts can be discarded. Seeds can be planted directly into pots or the soil, but keeping them in barely damp, warm peat moss until they sprout gives the advantage of only dealing with those seed which are viable.

There are 6 known species of macadamia but the two listed are the only ones recognised to have commercial potential. The two species hybridize readily, forming trees often more productive than either parent.

Macadamia integrifolia (smooth shelled macadamia)

Grows to 15 m tall and 4 m wide. This is the nut grown mostly for commercial purposes. It grows best in coastal areas. Leaves are usually arranged in threes. The new leaves are a pale green and the flowers are creamy white with few hairs. The nuts are usually round and smooth shelled.

Macadamia tetraphylla (rough shelled macadamia)

Growing to 20 m tall and 4 m wide, this species has a rough textured shell. The new leaves are red, the flowers are often pinkish and densely covered with hairs. It is often used as a rootstock for known cultivars of macadamias. It is much more adapted to inland conditions and is considered more resistant to the macadamia trunk canker caused by the root fungus *Phytophthora cinnamomii.* Seedlings of this species are very productive and produce a good edible nut, contrary to many sales peoples' advice.

WALNUTS *(Juglans spp)*

Family: JUGLANDACEAE

There are about 15 species of walnut, having a wide natural distribution from Europe to China, Japan and the Americas. Walnuts require a minimum rainfall of 760 mm (less with irrigation), a deep, rich soil which is well drained to a depth of at least three metres and containing large amounts of humus. The site must be free from extreme heat and late spring frosts. They are traditionally spaced 15 m x 15 m, although closer spacings of 12 m x 15m and 9 m x 15 m have produced greater yields per hectare. The closer spacings would be preferable for long term timber production, as they would result in longer trunks.

The leaves of walnuts, when fed to dairy cows are said to increase the butter - fat content of milk.

Juglans australis (Argentine walnut)

Native to Argentina and southern Bolivia. The nut is small and very thick. It is therefore not an ideal food tree. The wood is sought after, especially for making guitars.

Juglans boliviana (Bolivian walnut)

Native to the mountains of northern Bolivia and central and southern Peru. It is similar to *Juglans neotropica.*

Juglans hindsii (North Californian walnut)

The Californian walnut is a valuable timber species. It may prove to be a good root stock for other *Juglans* species.

Juglans neotropica (Andean walnut, nogal, Ecuadorian walnut)

A fast growing, **evergreen,** native of the Andes, which grows to around 30 m. Trees have been known to reach 10 m in 10 years in New Zealand. Because they come from high altitude (2,500 m) tropics, their climate is essentially temperate They tolerate temperatures between - 3°C and 40°C.

The trees grow well along stream banks, but also appear to be able to tolerate the hot dry summers of south west Western Australia without supplementary watering. They have a low chilling requirement.

This black shelled walnut is large with a very thick shell. This makes it ideal in parrot country, but reduces the amount of flesh in the nut and renders it harder to crack open. The nuts are eaten raw or used in pastries, sweetmeats and other confectionery.

The timber is hard, attractive and highly prized for cabinet making, carving and general woodwork. The quest for the valuable timber is threatening old stands in the Andes. Despite their value, they are even being cut for firewood in parts of the Andes where firewood is difficult to secure.

Propagation is by seed. Trials so far, suggest that direct planting of sprouted seed seems a viable method of establishing large plantings.

Juglans nigra (eastern black walnut)

This species is a large (to 33 m), fast growing native of North America. It has a good, strong timber, but is less attractive than J *regia.* Nevertheless, extremely high prices are paid for the timber. In the USA one log fetched $30,000 in 1986.

The nuts are unique among commercial nuts in retaining their flavour when cooked. Nutritional composition of the black walnut per 100 grams of edible portion is: Water - 3.1 %, Energy - 628 calories, Carbohydrate - 14.8 g, Fat - 59.3 g, Protein - 20.5 g, Ash - 2.3 g, Calcium - trace, Potassium - 460 mg, Sodium - 3 mg, Magnesium - 190 mg, Iron - 6.0 mg, Phosphorous - 570 mg, Vitamin A - 300 I.U., Thiamin - 0.22 mg, Riboflavin - 0.11 mg, Niacin - 0.7 mg and the digestion time is 3 hours.

The bark is used as an astringent, the leaves as a detergent, the rind as an hepatic. The bark infusion or decoction is taken for diarrhoea, to stop milk production and as a mouthwash. For ringworm the green rind of the nut is used as a poultice.

This tree is used as a root -stock for *J. regia* (budding is used in preference to grafting).

Juglans regia (Persian walnut or English walnut)

This walnut is a slow growing, broad - crowned tree up to 24 m high and is in common commercial use. Yields of 150 - 200 kg/tree have been recorded.

The nuts are eaten raw and in almost every conceivable form of cooking. Unripe fruits are added to jams, preserved in vinegar or syrup and made into brandy. The oil is used in cooking and on salads. The leaves, used as a tea, are a tonic to the stomach, promote good appetite and are used as a treatment for catarrhal enteritis. A decoction is used for rheumatism, gout, glandular swelling, scrofula, gum problems, sweaty feet, skin problems including acne and dandruff, and for excessive milk flow after a child has been weaned. A decoction of the green shell surrounding the walnut is recommended for failing virility.

Nutritional composition of the walnut per 100 grams of edible portion is: Water - 3.5%, Energy - 651 calories, Carbohydrate - 15.8 g, Fat - 64.0 g, Protein - 14.8 g, Ash - 1.9 g, Calcium - 99 mg, Potassium - 450 mg, Sodium - 2 mg, Magnesium - 131 mg, Iron - 3.1 mg, Phosphorous - 380 mg, Chlorine - 12 mg, Sulphur - 22 mg, Silicon - 12 mg, Iodine - 0.003 mg, Vitamin A - 30 I.U., Thiamin - 0.33 mg, Riboflavin - 0.13 mg, Niacin - 0.9 mg, Ascorbic acid - 2 mgs and the digestion time is 3 hours.

This is the most sought after walnut timber, as it has the most decorative grain, is durable, takes a high polish and is not prone to splitting. It has been the preferred timber for trimming in prestige cars, and is prized for gun butts because of its resilience.

Juglans venezuelensis (Venezuelan walnut)

A native to the coastal mountains of northern Venezuela, this species is now rare.

CHESTNUTS *(Castanea spp)*

Family: FAGACEAE

Close relatives of the oaks, the chestnuts are long lived, deciduous, drought resistant trees, thriving on well drained and preferably light soils. They have a fair lime tolerance but do not seem able to withstand salinity.

By year 10, a grove of chestnuts planted at a density of 56 - 70 trees/ha could be expected to yield 0.77 t/ha of nuts under minimal irrigation and 1.7 t/ha under full irrigation.

Castanea sativa (Spanish chestnut, sweet chestnut)

A large, spreading tree up to 35 m tall and having a girth up to 1 - 3 m. It is prized for its timber in Europe where the tree is coppiced. The young timber is tough and durable but the old growth wood is of little use except firewood.

Nut yields of mature trees can reach 5,000 kg per hectare. Chestnuts can be eaten raw, but are tastier freshly roasted, boiled or preserved by drying or pickling.

Nutritional composition of **fresh** chestnuts per 100 grams of edible portion is: Water - 52.5%, Energy - 194 calories, Carbohydrate - 42.1 g, Fat - 1.5 g, Protein - 2.9 g, Ash - 1.0 g, Calcium - 27 mg, Potassium - 454 mg, Sodium - 6 mg, Magnesium - 41 mg, Iron - 1.7 mg, Phosphorous - 88 mg, Iodine - 0.002 mg, Thiamin - 0.22 mg, Riboflavin - 0.22 mg, Niacin - 0.6 mg and the digestion time is 2.75 hours.

Nutritional composition of **dried** chestnuts per 100 grams of edible portion is: Water - 8.4%, Energy - 377 calories, Carbohydrate - 78.6 g, Fat - 4.1 g, Protein - 6.7 g, Ash - 2.2 g, Calcium - 52 mg, Potassium - 875 mg, Sodium - 12 mg, Iron - 3.3 mg, Phosphorous - 162 mg, Chlorine - 1 mg, Sulphur - 300 mg, Silicon - 4 mg, Thiamin - 0.32 mg, Riboflavin - 0.38 mg, Niacin - 1.2 mg.

Castanea crenata (Japanese chestnut)

A smaller tree which coppices well. Strains have been developed which produce excellent crops of nuts.

***Castanea mollissima* (Chinese chestnut)**

This tree grows to about 20 m and is said to have a sweeter tasting nut than that of the European chestnut. It is much more resistant to the root fungus *Phytophthera spp,* which can kill trees, than the European chestnut.

***Castanea dentata* (American chestnut)**

This tall (30 m), deciduous tree was once one of the major deciduous trees of North America. In the early 1900's it was destroyed by a bark fungus and today-there are few trees surviving. Seed is still available however in North America from areas that seem to have escaped the blight. The nuts are said to be the sweetest of any species.

***Castanea alnifolia* (downy chinquapin, trailing chinquapin)**

Native to south eastern USA, this small tree usually clumps from underground stems. The nuts are small but of good quality.

***Castanea henryi* (Henry chestnut)**

A native of central and western China which can grow to 70 m. Nuts are reported to be excellent.

***Castanea ozarkensis* (Ozark chinquapin)**

A medium sized tree with small tasty nuts.

***Castanea pumila* (chinquapin, allegheny chinquapin)**

A native of North America, which rarely exceeds a small shrub in cultivation. The nuts are smaller than for *C. dentata* and are very sweet, being eaten either raw or roasted.

***Castanea seguinii* (Chinese chinquapin)**

A large shrub or small tree from central and eastern China. It is a heavy bearer at an early age and produces small nuts with a good flavour.

CHINQUAPINS *(Chrysolepis spp)*

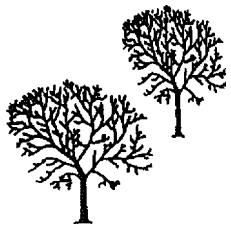
Family: FAGACEAE

***Chrysolepis chrysophylla, syn. Castanopsis chrysophylla* (golden chinquapin)**

Although not classed as a *Castanea spp*, this tree is very closely related and has most of the same features as chestnuts, with the marked distinction that it is an evergreen. It is native to mountainous western North America and may grow to 40 m with a very large girth. It does best in well drained acid or neutral soils. The sweet nuts are hard shelled and about 10 mm long.

***Chrysolepis sempervirens* (bush chinquapin, Sierra chinquapin)**

An evergreen shrub more suited to lower elevations than *C. chrysophylla.* The sweet nuts resemble filberts and can be eaten raw or roasted.



ALMONDS *(Prunus amygdalus)*

Family: ROSACEAE

The almond is a vigorous tree, growing to a height of 8 - 10 m, and reaching maturity at about 7 or 8 years, although it can begin to bear nuts in year 3 or 4. Its productive life can be as long as 50 years, and will yield 4 - 12 kg of kernel per year.

Nutritional composition of the almond per 100 grams of edible portion is: Water - 4.7%, Energy - 598 calories, Carbohydrate - 19.5 g, Fat - 54.2 g, Protein - 18.6 g, Ash - 3.0g, Calcium - 234 mg, Potassium - 773 mg, Sodium - 4 mg, Magnesium - 270 mg, Iron - 4.7 mg, Phosphorous - 504 mg, Chlorine - 6 mg, Sulphur - 96 mg, Silicon - 4 mg, Iodine - 0.002 mg, Thiamin - 0.24 mg, Riboflavin - 0.92 mg, Niacin - 3.5 mg and the digestion time is 2.5 hours.

Almonds are best adapted to areas with warm, dry summers, as the nuts will not reach maturity if summers are cool and humidity liigh. They are fairly cold hardy and also tolerant of drought, although yields are drastically reduced if grown under moisture stress. They require some winter chilling to break dormancy, although the blossom is very susceptible to spring frosts.

Almonds prefer deep, fertile, well drained loams or sandy loams, with the roots being found as deep as 3 m. They are very sensitive to poor drainage, therefore it is preferable not to have an impervious layer within 3 m of the surface. They will not tolerate salty soils.

Almonds are propagated by budding the chosen cultivar onto a rootstock. There are three popular rootstocks available. Peach seedlings produce faster growing trees, with roots that penetrate less deeply than almonds. The mature tree is smaller and does not live as long. The roots are susceptible to nematodes. Nemaguard is a peach rootstock with resistance to nematodes. This is the most popular rootstock, producing a vigorous tree which yields good crops.

Almond seedlings produce long lived, large, vigorous trees with deep penetrating roots. Easily affected by nematodes and *Armillaria.*

With the exception of a few cultivars such as "All - in - one" and "Garden Prince", almonds require cross - pollination with another variety.

Planting distance is 7m x 7m, planting four rows of the main cultivar to two rows of the polliniser (one early, one late). Closer planting of almonds generally has only limited success.

Trees should be pruned to maintain an open "vase" shape, keeping the centre open to prevent shading of the crop. Almonds bear most of their fruit on short laterals or spurs, which usually produce for 5 - 6 years and then die out. Pruning to replace branches with spurs past their prime will ensure vigorous growth of new spurs.

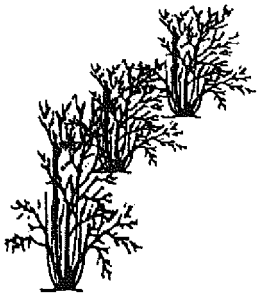
Almonds should be harvested after the hulls have cracked open and are partially dried. Nuts can be knocked or shaken from trees. Hulls should be removed and placed in the sun to dry for one to two days and stored in a dry, well ventilated place. Almonds in the shell will keep for up to six months.

Cultivars

Almond cultivars are classified into three groups: papershelis, having soft crumbly shells; softshells, which have a firm shell which can be broken by hand; and hardshells which need to be cracked open.

All-in - one	A softshell similar to Nonpareil. The tree is small, vigorous, upright and bears heavily. Good quality nut with a sweet flavour. Self - fruitful. Late harvest.
Baxendale	A softshell and a good polliniser for Nonpareil, blooming earlier.
Bigg's hardshell	The kernels are small to medium size and flat. Has a very hard shell.
Brown Brandis	A softshell, which is a very early flowering cultivar, therefore susceptible to frosts and tends to produce light crops.
Bruce	Similar to Johnson's prolific, with a softshell. The nuts are long and rather flat and normally used for the in - shell or blanching trade.
Carmel	Small to medium, softshell tree, producing heavily. Kernel is small, plump and long and has a good flavour. Pollinisers are Nonpareil, Merced and Price. Late harvest.
Chellaston	One of the main softshell cultivars grown in Australia. A fairly upright tree and a consistent producer of small to medium sized nuts, which are plump with good flavour. Can be susceptible to shothole disease.
Davey	A large upright tree but not a good producer. The papershell nuts are small to medium and the kernels plump and light brown.
Fritz	Often producing very heavy hardshell crops. Good polliniser to Nonpareil.
Garden Prince	A dwarf tree, reaching 3 m tall at maturity. A productive tree with sweet flavoured, medium, hardshelled kernel. Self - fruitful. Late harvest.

Hall	The tree is hardy and bears heavily. Good for late frost regions. Good sized, hardshell nut, but with a bitter flavour. Partially self - fruitful or pollinated by Mission.
IXL	There are two cultivars, American IXL and Australian IXL, the latter having slightly larger nuts. Both are papershell.
Johnson's Prolific	Often biennial in its cropping habit. Vigorous tree, produces large, softshelled nuts. Less susceptible to shothole than Ghellaston but more susceptible to bacterial gummosis. A main polliniser for Ghellaston.
Jordanolo	Blooms very early but is susceptible to bud failure. The softshell nut is long with attractive kernel.
Jose's B2	One of the largest nuts, softshelled, elongated and plump, with a high percentage of doubles.
Merced	Small to medium, vigorous, upright tree, producing heavily. Small, papershell nuts, broad kernels. Pollinisers are Nonpareil and Carmel. Mid - season to late harvest.
Mission or Texas	The tree is large, vigorous and upright in its growth and easy to train. An important cultivar in California. A good late polliniser for Nonpareil. Safe for late frost areas. The hardshell nuts are small and round with well sealed shells, but with a slightly bitter flavour. Pollinisers are Thompson and All - in - one. Late harvest.
Ne Plus Ultra	The tree is medium sized with a spreading form which makes for easy harvesting. Subject to frost damage and has a low chilling requirement. This papershell cultivar has lost popularity due to its poor quality kernel and tendency to produce double kernels. Pollinisers are Nonpareil, Peerless and Price. Mid - season harvest.
Nonpareil	A popular papershell cultivar in California and now widely planted in Australia. A large tree and a consistent producer of good quality nuts. Easily harvested and hulled. Susceptible to bird damage. Pollinisers are Ne Plus Ultra, Carmel, Price and All-in - one. Early harvest.
Peerless	Medium, spreading tree. Susceptible to late frost. Bears a very large hardshell nut with medium sized good quality kernel. Pollinisers are Nonpareil and Ne Plus Ultra. Early season.
Pethick's Wonder	An Australian cultivar from the Marion district. An upright tree which is often a biennial producer. The softshell nuts are medium sized.
Price	Medium sized tree which bears heavily. Softshell nuts are plump and poorly sealed. Pollinisers are Nonpareil, All-in-one, Merced and Carmel. Mid - season harvest.
Strout's Papershell	The tree is slightly weeping in habit and a mediocre producer of medium sized nuts, which are used in the kernel trade.
Thompson	Medium sized tree bearing small nuts with well sealed shell. The nut is softshell and the kernel is good quality with a mild, bitter flavour. Pollinisers are Mission and All-in - one. Mid - season harvest.
White Brandis	Similar to Chellaston in its growth habit. Good early polliniser for Chellaston and other early cultivars. Nut is softshell with plump, good flavoured kernels.



HAZELNUT *(Corylus spp)*

Family: CORYLACEAE

The hazelnut is a small tree growing to a height of about 5 m, with a spread of about 5 m.

The main variety grown commercially is the European hazelnut *(Corylus avellana),* although the Mediterranean hazelnut *(Corylus maxima),* also known as the filbert, has provided the basis for many varieties and crosses. In the USA all varieties of hazelnut are known as filberts, but in Europe those varieties where the husk is longer than the nut, are known as filberts, whereas varieties having husks shorter than the nut are known as cob varieties.

The hazelnut will begin bearing nuts at about 4 years of age, and can be expected to live for about 50 years. It does not often yield a heavy crop of nuts in Western Australia, as it has a high chilling requirement and the winters are generally not cold enough. The chilling requirement varies from 800 to 1600 hours at temperatures less than 7°C, depending on varieties. The flowers will however, survive at temperatures as low as - 20oC. In Victoria, yields of hazelnuts have been recorded from 0.28 kg/tree at 3 years of age, to 6.6 kg/tree at 11 years of age, with a potential to produce up to 20 - 25 kg/tree at full maturity.

Because the male flowers (catkins) produce pollen before the female (pistillate) flowers on the same tree are receptive, hazelnuts need a polliniser of a different variety, which will produce pollen at the appropriate time. The nuts will begin to appear in late spring and most of them will reach full size by the end of December. By the middle of February the nuts should be fully ripe.

Hazelnuts grow best in deep, well - drained, loamy soil and require little added fertiliser. In dry areas, irrigation is required for good nut production. A neutral pH is preferred. The recommended planting distance is about 5 m, although they can be grown as an understorey to larger species of orchard trees. The hazelnuts can also be intercropped with strawberries or other berries, vegetables or flowers. Alternatively, a green manure crop could be grown.

If the hazelnut is grown as a shrub, little pruning is required, although for optimum yields it is desirable to remove most of the suckers. If it is grown as a tree, the suckers and some branches will need to be removed. It is best trained as a central leader, that is, all side limbs growing from a main trunk. Pruning both the tree and shrub forms should be aimed at increasing the amount of light reaching the centre of the tree and to maximise the amount of one - year old fruiting wood. Old or weakened trees can be rejuvenated by cutting back to the soil surface and allowing new suckers to regenerate.

Propagation can either be from seed, sucker or by layering. When growing from seed, stratification is necessary for a period of 60 - 100 days, depending on variety. Seedlings however, seldom retain the characteristics of the parent tree.

Nuts should be harvested as they fall from the tree, being gathered as often as possible. They can be sun - dried and stored in the shell for many months in a cool place. The shelled kernels will keep for several weeks at room temperature.

Nutritional composition of the hazelnut per 100 grams of edible portion is: Water - 5.4%, Energy - 634 calories, Carbohydrate - 16.7 g, Fat - 62.4 g, Protein - 12.6 g, Ash - 2.5 g, Calcium - 209 mg, Potassium - 704 mg, Sodium - 2 mg, Magnesium - 184 mg, Iron - 3.4 mg, Phosphorous - 337 mg, Chlorine - 60 mg, Sulphur - 446 mg, Iodine - 0.002 mg, Thiamin - 0.46 mg, Niacin - 0.9 mg. and the digestion time is 3 hours.

When coppiced, the young wood is used for sheep hurdles, cask hoops, crates and walking sticks. The wood also yields good charcoal. The leaves have potential for animal fodder.

Cultivars

Barcelona	A slow - growing tree producing excellent nuts. One of the best varieties. Pollinisers are Du Chilly, Royal and Daviana.
Du Chilly	Large nuts of good quality, but slow to drop and difficult to husk. Pollinised by Daviana.
Royal	Large, early nuts. Pollinised by Daviana.
Daviana	Long nuts and a very good polliniser. Pollinated by Barcelona or Hall's Giant.
Hall's Giant, Bolwyer	Large nuts. Pollinated by Barcelona, Royal or Daviana.

White Lambert (Barcelona group)	One of the oldest varieties, from southern Europe or north Africa. A shrub of moderate vigour and height. Bears early and is a consistent yielder. The nuts are fairly large, with a thin, soft shell. It has a large kernel with a sweet flavour, and is easy to separate from the shell. Keeps well.
Red Lambert (Barcelona group)	Similar to the White Lambert. A good variety for cross pollination.
Cosford (Daviana group)	A prolific producer of hardy catkins, this is a small shrub that starts to produce at 2 years old. A moderate sized nut with a good nutty flavoured kernel which tends to shrivel during storage.
American White	Similar to Cosford and an excellent variety.

PECAN *(Carya illinoensis)*

Family: JUGLANDACEAE

The pecan belongs to the same botanical family as the walnut and also belongs to the same genus as the hickory, with which it is cross fertile. It is a native of North America, and although it was introduced to Australia many years ago, it only became a commercial crop in the early 1970's. Pecans are long - lived trees and grow as tall as 100 m. They begin to bear nuts at 6 - 7 years of age and reach maturity at 15 - 20 years. A mature tree can produce up to 50 kg of nuts, but 20 - 30 kg is more usual.

Nutritional composition of the pecan per 100 grams of edible portion is: Water - 3.4%, Energy - 687 calories, Carbohydrate - 14.6 g, Fat - 71.2 g, Protein - 9.2 g, Ash - 1.6 g, Calcium - 73 mg, Potassium - 603 mg, Sodium - trace, Magnesium - 142 mg, Iron - 2.4 mg, Phosphorous - 289 mg, Vitamin A - 130 I.U., Thiamin - 0.86 mg, Riboflavin - 0.13 mg, Niacin - 0.9 mg, Ascorbic acid - 0.9 mgs and the digestion time is 2.75 hours.

Pecans prefer long summers and appear to grow best where the summer temperature range is within 24 - 30°C, although no extensive research has been carried out on temperature requirements. Some winter chilling is necessary to set fruit but the pecan is sensitive to frosts during the growing season. Different cultivars require different lengths of growing season, so selection of a suitable variety is important. In areas where the growing season is 230 days or more, choice of cultivars is unlimited. The pecan grows naturally in areas of high humidity, but it has been found that pollination is better where humidity is lower. Pecans need an abundance of soil moisture, but rainfall at flowering and harvest times can lower production, as can wind or hail storms.

Pecans will grow on a wide range of soils, providing they are fertile and well drained, with a good water holding capacity. Neutral soils are preferable, but a pH range of 6 - 8 will be tolerated. They will not grow on soils that are at all saline.

The pecan has both male and female flowers on the same tree and is wind pollinated. It is also self - fertile, but better quality nuts are produced when cross - pollinated. Different cultivars should be planted together to ensure adequate pollination.

Pecans are usually budded or grafted onto seedling rootstock, the most popular being Riverside and Apache.

Traditionally, orchards were planted at 15 m x 15 m although with newer cultivars, 5 m x 10 m or 7.5 m x 7.5 m is the more usual spacing.

Pruning consists of removing weak, dead or broken branches, and branches that cross or are otherwise wayward. The tree produces fruit on its new growth, so extensive pruning will result in lower yields. In older trees, some pruning will be required to stimulate growth and maintain production.

The pecan is susceptible to very few pests and diseases in Australia as yet, the main problem being parrots and cockatoos.

Cultivars

There are over 500 cultivars of pecan in existence, although many of these are no longer commercially grown. Some of the more important ones are:

Apache	Mid - season vigorous variety producing high quality nuts. Upright and spreading. Vigorous seedlings can be used as rootstock.
Candy	A short season cultivar with small, early maturing nuts. It is a heavy bearer. Pollinisers are Cherokee, Moore, Cheyenne.
Cherokee	A very early bearing and high yielding cultivar. Medium sized nuts. Pollinisers are Chickasaw, Candy, Shoshoni. Not easy to grow.
Cheyenne	A very precocious and high yielding variety. Very good quality nuts. It is small, open and a good cultivar for high density plantings, although yield / tree is low. Matures mid - season and has a growing season of 180 - 200 days. Pollinisers are Shoshoni, Tejas, Chickasaw.
Chickasaw	A precocious tree and prolific variety with open and spreading habit. Early maturing nuts and has a 180 - 200 day growing season. Pollinisers are Cheyenne, Western Schley.
Chocktaw	A vigorous, precocious tree and a prolific bearer of large nuts. A mid - season variety. Pollinisers are Cheyenne, Western Schley.
Desirable	An old cultivar, with open, spreading form. Moderately precocious, consistent producer of fairly large, attractive nuts, with good flavour. Excellent early polliniser
Kiowa	A vigorous tree with upright, spreading habbit. It is a moderately precocious cultivar, bearing large nuts. Pollinisers are Cherokee, Moore, Western Schley.
Moore	A small, spreading, pendulous tree, which bears heavily, although nuts are small. Matures early. Pollinisers are Candy, Shoshoni, Chickasaw.
Mohawk	A vigorous, semi - spreading tree, producing a large nut of good kernel quality. Mid - season and usually self - fruitful. Pollinisers are Cheyenne and Western Schley.
Shoshoni	A very upright variety, therefore good for high density plantings. It is a prolific and precocious bearer of large, early maturing nuts. Has a 180 - 200 day growing season. Pollinisers are Cheyenne, Western Schley, Success.
Stuart	A vigorous tree, but slow to start producing. A mid - season variety with average size nuts. The growing season is 180 - 200 days. Pollinisers are Cherokee, Moore, Cheyenne.
Success	An old cultivar with moderately vigorous growth habit. A mid - season variety, producing a large nut, often poorly filled. The growing season is 200 - 210 days. Susceptible to disease. Pollinisers are Candy, Chickasaw, Shoshoni.
Tejas	An upright, compact variety, moderately precocious. A fairly prolific producer of good quality nuts and has a growing season of 180 - 200 days. Pollinisers are Cheyenne, Cherokee, Western Schley.
Western Schley	An old cultivar which is a vigorous grower with open, spreading habit. Widely planted in the USA. Moderately precocious and a prolific bearer. Nuts mature mid - season and has a growing season of 210 - 220 days. Pollinisers are Wichita, Tejas, Kiowa, Chickasaw.
Wichita	A precocious, upright, spreading tree and a prolific bearer which does well in warmer areas. Bears early, producing an attractive kernel. Growing season is 210 - 220 days. Pollinisers are Cheyenne, Cherokee, Western Schley.

PISTACHIO NUTS *(Pistacia spp)*

Family: PISTACIACEAE

Pistacia vera (pistachio)

A native of western Asia and Asia Minor, the pistachio is a long lived, relatively slow growing, deciduous tree, with a spreading growth habit, eventually reaching a height of 10 m.

It prefers a deep, fertile soil, but is remarkably adaptable to different soil types, as long as there is sufficient depth of soil and it is well drained. It will tolerate a wide range of pH in the soil and will tolerate about twice the degree of salinity as most other fruit and nut trees. Its climatic requirements however, are more specific. It requires long, hot summers to produce the best crops, plus winter chilling, needing mean daily temperatures below 7 - 10°G in the winter. Spring frosts at around the time of flowering are likely to interfere with setting. The pistachio is drought tolerant, although responds well to irrigation.

Nutritional composition of the pistachio per 100 grams of edible portion is: Water - 5.3%, Energy - 594 calories, Carbohydrate -19.0 g, Fat - 53.7 g, Protein - 19.3 g, Ash - 2.7 g, Calcium - 131 mg, Potassium - 972 mg, Magnesium - 158 mg, Iron - 7.3 mg, Phosphorous - 500 mg, Vitamin A - 230 I.U., Thiamin - 0.67 mg, Niacin - 1.4 mg.

Trees can begin to crop in years 5 - 7, but may take up to 15 years before nuts are produced. They are dioecious, requiring both male and female trees, and flowers are wind pollinated. Usually, pistachio trees bear a crop biennially and are capable of producing in excess of 50kg of nuts per tree. The nuts comprise a single large seed inside a thin shell, which is surrounded by a thin hull. They ripen in early Autumn, when the fleshy hull becomes soft and partly separates from the shell. The shell splits open to reveal the kernel inside. Nuts are harvested either by being knocked off with sticks, picked by hand or shaken by a mechanical shaker. The nuts are then hulled and dried as quickly as possible to prevent spoilage of the kernels.

Trees are propagated by grafting onto the rootstocks of two other species of pistachio *(P vera* is not recommended as a rootstock as it grows slowly with a straggling habit). Spacing of trees is about 8 m, with the ratio of male to female cultivars being 1 to 9. Pistachios naturally form low bushy trees which are difficult to manage, so have to be trained to encourage a strong trunk and up to 5 main limbs.

Pistacia atlantica (butum, Mt Atlas pistachio)

A semi - evergreen to deciduous, slow to moderate growing tree (to 20 m), native to the Canary Islands and the Mediterranean region to the Caucusus and Pakistan. The tree is very hardy and can tolerate prolonged heat, drought, wind, cold and alkaline soil conditions.

It bears small turpentine fruits called gadum which are eaten raw in the Middle East. It is valued commercially for a resin which oozes from its branches to form tiny droplets and for its wood.

It is commonly used as a rootstock for *Pistacia vera* because it is resistant to nematodes and root - knot and prefers heavy soils.

Pistacia chinensis (Chinese pistachio, Huang - lien - mu)

This deciduous native of China grows to a height of 14 m. It prefers a light well drained soil.

The nuts are eaten roasted, the leaves and young shoots are eaten as a vegetable.

Pistacia terebinthus (Cyprus turpentine tree, terebinth pistachio)

Native to the Mediterranean region, this semi - evergreen tree grows to a height of 5 m. It grows on most soils.

The sweet, greenish nuts are eaten out of hand or the oil is extracted from them. Young leaves are cooked and used as a vegetable. In Iran, the resin from the trunk is used as a chewing gum. Immature fruits, still on a portion of stem, are preserved in vinegar and salt, and then made into a relish.

This species is also used as a rootstock for *Pistacia vera.*

BUNYA BUNYA *(Araucaria bidwillii)*

Family: AURICARIACEAE

A native, evergreen of south eastern Queensland in Australia, the bunya bunya is an erect conifer, reaching a height of up to 30 - 45 m with a spread of 10 m. The trunk can grow up to 1.5 m in diameter. It is frost tolerant and prefers a humid climate with rainfalls varying from 900 - 2000 mm. It usually grows as an emergent over tropical forest.

It is tolerant of soil types, as long as it has plenty of moisture and adequate drainage. It is frost tolerant to - 4°C.

The nut of the bunya bunya can grow as large as a walnut and is rich in starch. The tree was once plentiful and the nut was eaten, both raw and roasted, by the Aborigines. The Aboriginal name for the tree was *bon -yi.* The preferred food from the bunya bunya was the secondary food store which develops below the ground after the seed germinates.

The nuts can be used as a flour or boiled in their shells for about 20 mins and eaten hot. Nuts are likely to explode when being roasted.

The nuts are produced in large cones (up to 30 cm in diameter and weighing up to 7 kg) in late summer and autumn. The tree produces a litter which is very prickly and cones falling from the tree can be hazardous. Not the kind of tree for the back yard.

The timber is a white softwood and highly prized. Resin is harvested from injuries to the trunk and used by the Aborigines as a glue. Propagation is by seed, by cuttings from young branches and from suckers. The bark contains 10% tannin.

Araucaria araucana (Araucarian pine nut, monkey puzzle tree)

This native evergreen of Chile and Argentina grows from 15 - 35 m with a spread of 8 m. It prefers cool, moist, loamy soils and sheltered positions. Hot, dry conditions will often cause the tree to die. In the UK it is found to be very cold hardy and is considered an excellent wind resister there. It loses its lower limbs and becomes ragged from industrial pollution.

The tree is usually monoecious. The nuts, called pinones, are twice the size of an almond and rich in starch. They are roasted, boiled, eaten fresh and also made into an alcoholic drink. Eighteen good sized trees are reported to be able to yield enough to sustain an adult for a year. It is the national tree of Chile and is protected by the Araucanians, the native people of Chile.

Propagation is by seed and trees require frost protection for the first couple of years.

Araucaria braziliana, syn. augustifolia (Parana pine, Brazilian pine)

Native to Brazil and Argentina. It yields a large, nutritious nut with a sweet, mealy flavour somewhat resembling sweet potatoes. The gum of the tree is also eaten.

PINES WITH EDIBLE NUTS *(Pinus spp)*

Family: PINACEAE

There are more than 20 species of pine which bear edible pine nuts. Pines are conifers and evergreen.

Pines possess distinctive cones, which are either male or female. The edible nuts have excellent food value.

Many of the pinon pines are slow growing and only produce heavy crops every few years.

Dietary Value of Some Pine Nuts and Other Commercial Nuts

(based on Lanner)

Type of Nut	Protein (%)	Fat (%)	Carbohydrate (%)
Pinus cembroides	19	60	14
Pinus edulis	14	62-71	18
Pinus gerardiana	14	51	23
Pinus monophylla	10	23	54
Pinus pinea	34	48	7
Pinus sabiniana	30	60	9
Pinus sibirica	19	51 - 75	12
Pinus strobiformis	28	52	7
Pinus quadrifolia	11	37	44
Carya illinoensis (pecan)	10	73	11
Arachis hypogea (peanut)	26	39	24
Juglans regia (Persian walnut)	15	68	12

Pinus albicaulis (whitebark pine nut)

A native of western USA. This medium sized tree (to 15m with a spread of 4m) is frost resistant but drought tender. It is adaptable to most soil types but prefers an open sunny position.

The cones are 7.5 cm long and have tighdy closed scales which guard nuts. They are claimed to have "unsurpassed delicacy of flavour".

Pinus armandii (Chinese white pine)

A medium sized tree native to China. It bears decorative cones containing seeds which are esteemed as a great delicacy.

Pinus ayachuite (Mexican white pine)

This tall (to 35 m and spread of 5 m) tree is native to Mexico. It is said to be frost and drought tender.

Pinus cembra (Swiss stone pine)

A small to medium sized tree native to the mountains of central Europe and northern Asia. The seed is used in pastries and dairy food. The seed contains an edible oil. The cones do not release the seed.

Pinus cembroides (Mexican pinon)

A small, rustic tree with a short trunk, found in the higher rocky foot hills of Mexico and Arizona at altitudes up to 2000 m. It is a slow grower in its natural habitat but very wind, cold and drought hardy. The oily seeds are eaten raw or roasted. They are ground to flour for breads and cakes or made into a nut butter.

Pinus coulteri (coulter pine nut, big - cone pine)

Occurring naturally on dry rocky mountain slopes in California at altitudes of 1000 - 2000 m, the coulter pine reaches a height of 10 - 25 m with a large spread. It is slow growing and requires an average annual rainfall of 500 - 750 mm. It is resistant to heat, cold and wind.

The pine cones are the largest in the genus, with a length of 25 - 35 cm and diameter of up to 15 cm. The edible seeds are also large (up to 12 mm in length). Cones are generally produced every other year, and the tree grows freely from seed.

Pinus edulis (two - leaved pine or Colorado pinon)

Native to the higher regions of the south west of the USA (from California to Texas and Mexico), *Pinus edulis* is the producer of the commercial pine nut of the USA. It is slow growing, eventually reaching a height of 4 - 8 m, although may grow taller. Usually irregular in shape, it is flat or rounded, with horizontal branches. It is drought tolerant and cold hardy, but also thrives in the heat of the deserts.

The cones are rounded, light brown in colour and about 5 cm in length. The nuts are small and tasty and are collected as a delicacy by the native Americans. The seeds are oily and eaten raw or roasted. They are used in breads, biscuits, nut butters, ice cream, sauces, stuffings, and confectionery. They are ground into a meal and used in puddings, soups and gruels. They can be mixed with cornmeal or sunflower seed meal. The needles are brewed into a tea and the unripe cones are roasted to produce a syrupy food. The sweet cambium is cut into thin strips and cooked like spaghetti.

Nutritional composition of the pinon per 100 grams of edible portion is: Water - 3.1%, Energy - 635 calories, Carbohydrate - 20.5 g, Fat - 60.5 g, Protein - 13.0 g, Ash - 2.9 g, Calcium - 12 mg, Iron - 5.2 mg, Phosphorous - 604 mg, Vitamin A - 30 I.U., Thiamin - 1.28 mg, Riboflavin - 0.23 mg, Niacin - 4.5 mg, Ascorbic acid - trace.

Pinus fiexilis (limber pine nut)

A medium sized tree of conical shape, native to the Rocky Mountains of western North America. The Indians and the early setders ate the seeds.

Pinus griffithii, syn. Pinus wallichiana (Indian blue pine)

Similar to *P. pinea* but native to the Himalayan Mountains, thriving at altitudes of up to 4000 m above sea level. It reaches heights of 30 m and widths of 5 m. It is frost resistant but said to be drought tender. It is moderately lime tolerant but not suited to shallow chalk soils.

The seeds are sometimes eaten, as is a manna - like substance which exudes from the leaves and twigs. The manna is also sometimes used to adulterate honey.

Pinus jeffreyi (Jeffrey pine nut)

A native of south western USA, this large tree (to 60 m with a spread of 6 m) with a conical or spire - like crown is both drought and frost hardy. The large seeds are eaten.

Pinus johannis (Johannis pinon)

A small tree or shrub rarely exceeding 3 m. It grows on limestone slopes in Mexico and seems closely related to *Pinus cembroides.*

Pinus lambertiana (sugar pine nut)

A native of the Pacific coast of North America, this is the largest of all pines reaching a height of 75m and a spread of 6 m. It is said to be frost resistant but drought tender.

The cones are up to 50 cm long and bear a nut rich in sugar and oil which is eaten raw, roasted or pressed into cakes. When cut or wounded the heartwood exudes a sap that forms sugar like lumps which is used for sweetening food. When used in quantity it is cathartic.

Pinus maximartinezii (Martinez pinon)

This pine is a recent discovery to science, growing in a remote canyon and nearby hills in Mexico. It grows from 6 - 10 m tall at altitudes between 1600 m and 2000 m. Trees cling to vertical walls of steep canyons. The cones are up to 30 cm long, weighing nearly 2 kg when green and contain edible seed which are very large (up to 2 cm long) and said to be very tasty.

Pinus monophylla (single - leaf pinon pine)

A small, hardy, drought - resistant native to the higher rocky foothills from Idaho to Mexico. This species is rugged in appearance and a slow growing pinon.

Seeds are eaten raw or roasted. They are also ground and made into pancakes. The cones take three separate growing seasons or a time span of 26 months to mature and are susceptible to adverse weather conditions, such as frosts or heavy and prolonged spring rains during the developmental periods. There also tend to be cycles of good and poor years, with a good crop one year often followed by several poor years.

Pinus pinea (stone pine, Italian stone pine, umbrella pine)

Native to the Mediterranean, the stone pine is a handsome tree, reaching 12 - 25 m in height, with a large, spreading, crown. It has a slow to moderate growth rate, but is long lived (60 - 100 years). Thinning the trees interior will increase the growth rate. It grows well in most soils, apart from alkaline soils and impermeable clays, in areas receiving at least 400 mm mean annual rainfall. It will tolerate both hot summers and light frost.

Although it provides a good windbreak when young, older trees tend to lose their lower needles as a result of shading. Because of its umbrella shaped crown, it is also an excellent shade tree.

It produces the edible pignolia nut, the growing of which is an important commercial industry in Europe. The seeds are eaten raw or roasted and salted. They are used in sweetmeats cakes, puddings, biscuits, soups, etc. In Romania the young cones are used whole to flavour game sauces.

Nutritional composition of the pignolia per 100 grams of edible portion is: Water - 5.6%, Energy - 552 calories, Carbohydrate - 11.6 g, Fat - 47.4 g, Protein - 31.1 g, Ash - 4.3 g, Thiamin - 0.62 mg and the digestion time is 2.75 hours.

Pinus quadrifolia (Parry pinon)

The oily seeds are an important food of the Indians of Baja, California.

Pinus sabiniana (digger pine)

The digger pine is a native to the arid foothills of Sierra Nevada and coastal ranges of California, at altitudes of 120 - 1200 m. It is a medium sized tree, usually of gaunt open habit, with straggly branches. It can reach 15 m in 15 years and can eventually reach 22 m. It is drought and cold tolerant and will grow on light, shallow soils. It requires an average annual rainfall of 500 - 750 mm.

Closely related to the coulter pine, it bears large cones to 25 cm long and produces regularly. The large oily seed are eaten raw or roasted. The soft centre of green cones can be roasted and eaten. The leaves are used for tea. American Indians used the roots to make baskets.

It grows readily from seed and does not need cold treatment. Other plants can grow under it as it does not produce a dense shade. It is a useful shade and shelter tree, but not a good timber species.

Pinus torreyana (Torrey pine nut, soledad pine)

The natural occurrence of the Torrey pine is limited to a small area of the San Diego coast and to Santa Rosa Island of Southern California. In these arid areas, it varies from a semi - prostrate shrub to a small, heavily branched tree, 10 - 16 m in height. In wetter areas of New Zealand (1250 mm average annual rainfall), it has attained heights of over 30 m in 35 years and is moderate to fast growing. It prefers moderately fertile, sandy loams, but will grow on a wide range of soils except heavy clays or saline soils. It is frost hardy to - 11°C.

The large edible seed is eaten raw or roasted. It produces seed somewhat irregularly (4-5 year intervals for good crops). It is a good timber species. It will not tolerate bare - rooted planting.

JOJOBA *(Simmondsia chinensis, syn. Simmondsia californica)*

Family: SIMMONDSIACEAE

The name jojoba (pronounced ho ho ba) comes from the original native American Hohowi. Other common names include: goat nut, pig nut, coffee bush and deer nut.

Native of the Californian Gulf region and particularly the Sonoran Desert, this drought tolerant evergreen shrub has been recorded growing to a height of 5 m with a spread of 6 m. The trunks are usually multi - stemmed and have been recorded up to about 400 mm diameter. The tree lives for over 100 years.

Established plants are capable of withstanding temperatures as low as - 9°C without long term damage but flower buds and new seed can be damaged at - 2°C. Soil temperature can reach as high as 65°C with ambient air temperature as high as 48°C. Within the plant's natural distribution both summer and winter rainfall areas are experienced so the plant seems able to cope with either. Although the plant will establish in areas as low as 200 mm of rainfall, most production occurs above 400 mm. Where drainage is good it can grow in areas up to 1300 mm rainfall. The plant will not tolerate waterlogging. Valley bottoms are usually avoided because of increased cold and moisture. It seems tolerant of most soil types but needs reasonable porosity. Jojoba is very resistant to saline water. Trials have shown no loss of production at 7,000 ppm.

The edible nuts are eaten raw or roasted. It is also used by early settlers to make a coffee substitute. The Coahuila tribe used them to make a drink. The nuts were ground and boiled then the liquid strained off. The Mexicans also made a drink by grinding roasted nuts with hard boiled egg yolk. The resulting paste was boiled with water, milk and sugar. Vanilla was added to taste. The drink is said to resemble thick chocolate.

The oil, easily extracted from the nut, is a liquid wax which is very rare, valuable and highly prized in industry It is used for cosmetics and shampoos but also as a high grade lubricant for quality machinery. It is used where previously only sperm whale oil was used. The oil cake remaining after extraction and treatment is high in protein (30%) and considered a good stock feed.

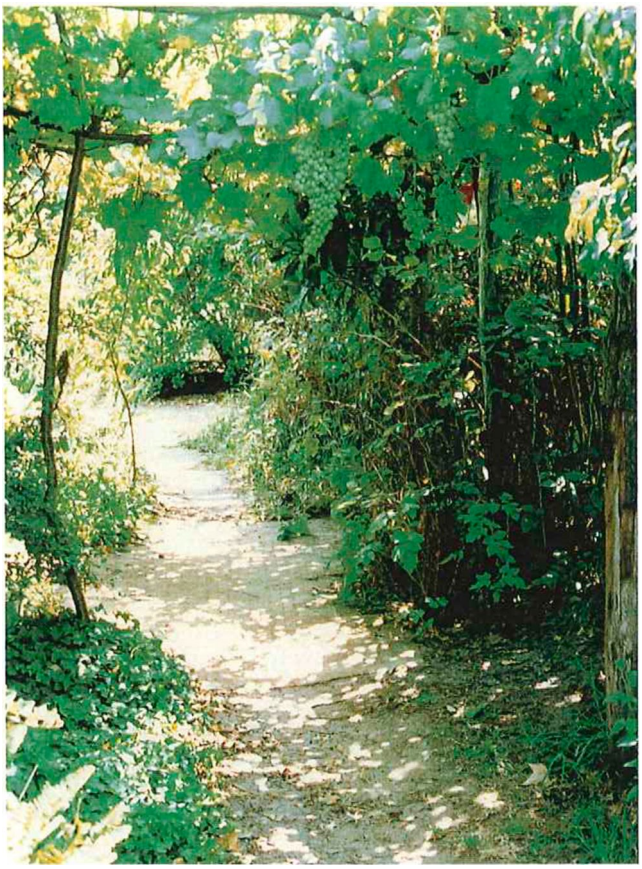
In its native environment, the plant is browsed by deer, cattle, sheep, goats, crows, pigeons, jays and rodents.

The plant can be grown as an unkept hedge. Many people have been disillusioned by promises of instant wealth from jojoba. This has resulted in a certain apathy toward the plant which seems to have stopped a lot of people from even trialing a few plants.

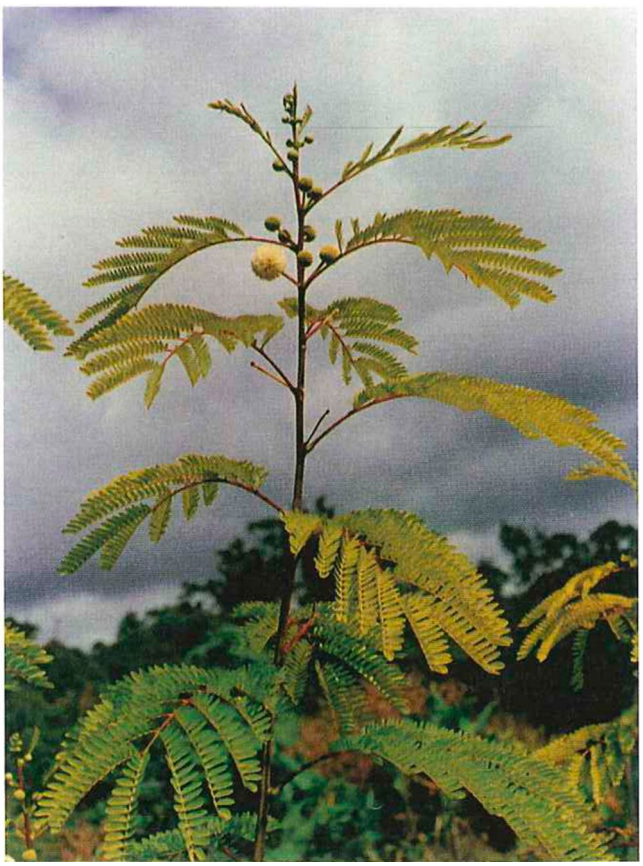
Shaded play under a loquat *(Eriobotrya japonica).* In the late spring, when the evergreen tree is fruiting and the ultra violet radiations are at their highest, it also serves as shaded child forage. Nannup, Western Australia.

Pioneer: *Acacia saligna* hedge planted onto earthworks. Flowering of front tree is significantly advanced to others on the left. These are the erect, low suckering form. Nannup, Western Australia.

Pioneers: stepping forest into clearing. Natural regeneration of raspberry jam wattles. Yelbeni, Western Australia.

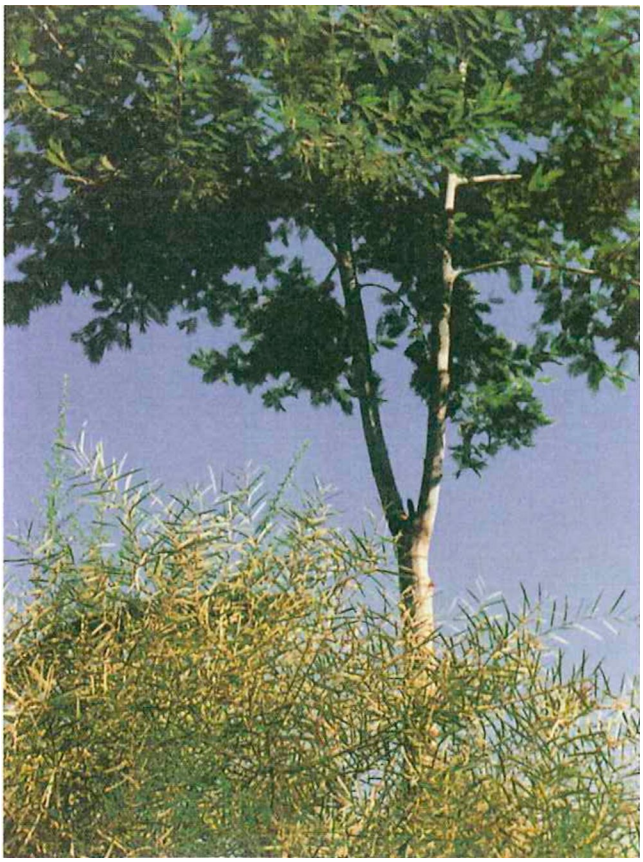


Shaded walk. Nannup, Western Australia.



Pioneer: *Leucaena leucocephala (var. Peru),* showing flower which quickly distinguishes it from *Albizia lophantha.* Nannup, Western Australia.

Pioneer: honey locust *(Gleditsia triacanthos)* pod. High nutrition stockfeed. Busselton, Western Australia.



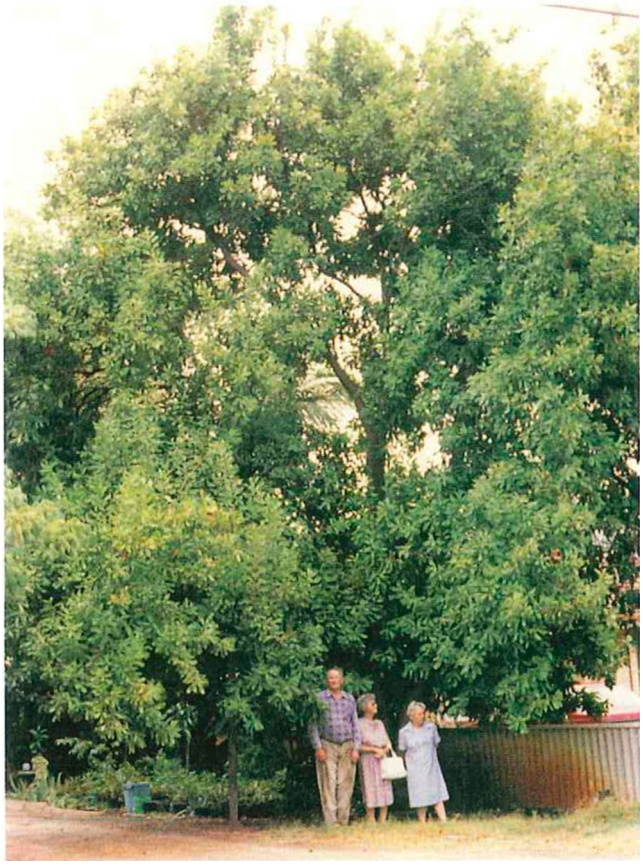
Pioneer: *Acacia dealbata,* pruned high for pole, emerging from behind *Acacia iteaphylla.* Both forming sun trap for sub-tropical microclimate. Nannup, Western Australia.

Pioneer: one year old tagasaste planting. Trees were planted bare rooted at 2 m spacing in central wheatbelt (300 mm rainfall), with only 50 mm of rain left in the season. No supplementary watering over hot dry summer. Success rate 85%. Yelbeni, Western Australia.

Two years later. Trees provide windbreak to stock and crop, and form wildlife corridor from bush at the back. This allows small insect eating birds to penetrate deep into the crop.

Pioneer: *Albizia lophantha* creating micro-environment for seedling white sapote *(Casimiroa edulis).*

Macadamia Nuts.

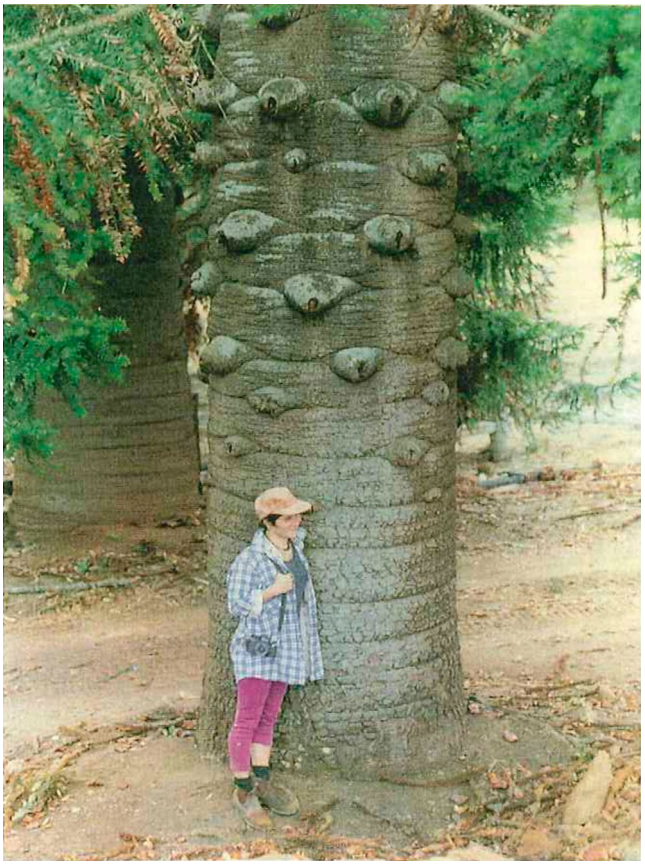


Nuts: 35 year old macadamia tree.
Perth, Western Australia.

Utility: Portugese oak *(Quercus lusitanica)* planted over pig yards. Acorns are stock feed. Tree is semi-deciduous.
Manjimup, Western Australia.

Nuts: chestnut coppice. The root system is well established and allows quick recovery and growth.
Sussex, England, (photo: Julia Boniface)

Utility: Quito palm *(Parajubaea coccoides)* Seed from Quito, Ecuador. Seed can take 18 months to germinate. Note sprout on the right of seed. The nut has the flavour of coconut.
Nannup, Western Australia



Nuts: detail of bunya trunk with roving photographer Claire Everette.
Bridgetown, Western Australia.

Nuts: bunya trees *(Araucaria bidwillii),*
Bridgetown, Western Australia.

Nuts: jojoba *(Simmondsia chinensis),* 18 months from seed showing flower of female and male plant.
Nannup, Western Australia.

Nuts: Andean walnut *(Juglans neotropica),* 1 year from seed.
Nannup, Western Australia.

Prickly pear *(Opuntia sp)* forming fruiting, fence barrier.
It is also a good fire barrier.
Perth, Western Australia.

Fruit: banana passion fruit *(Passiflora mollissima).* Fruit and flower and purple fruited granadilla *(Passiflora edulis).*
Nannup, Western Australia.

Fruit: white sapote *(Casimiroa edulis).* Detail of blossom on branch.
Nannup, Western Australia.

Fruit: Pepino *(Solanum muricatum)* fruit and blossom.
Bears for up to 6 months of the year.
Nannup, Western Australia.

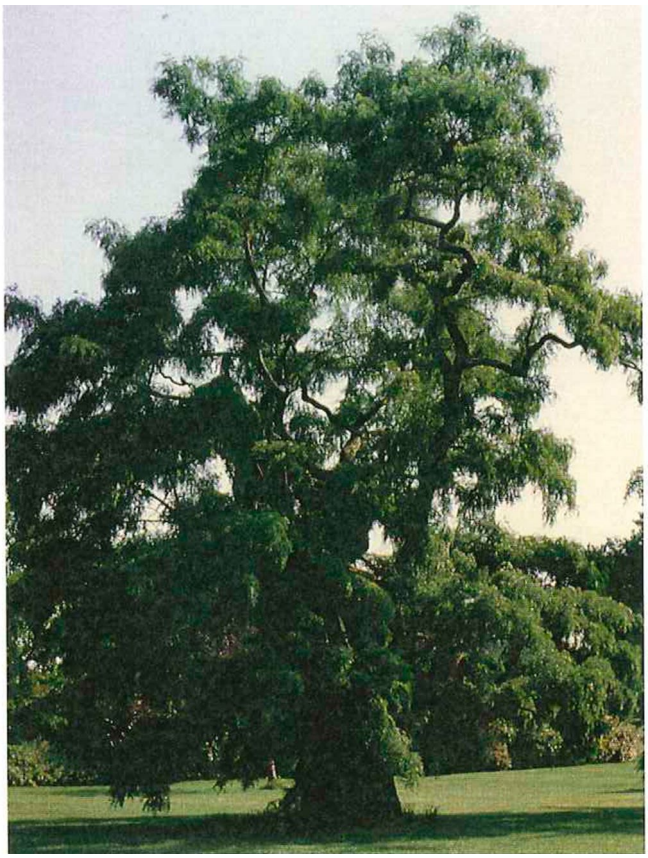
Fruit: tamarillo *(Cyphomandra betacea),* full fruit, 18 months from seed.
Nannup, Western Australia.

Fruit: capulin cherry *(Prunus salicifolia),* 3 years old from seed.
First fruits, year 2.
Nannup, Western Australia.

Utility: Chilean wine palm *(Jubaea chilensis)*
The nut has the flavour of coconut.
Perth, Western Australia.

Fruit: lillipilli *(Eugenia smithii)* in flower.
Nannup, Western Australia.

Fruit: Moreton Bay fig tree. Same tree as below,
Perth, Western Australia..



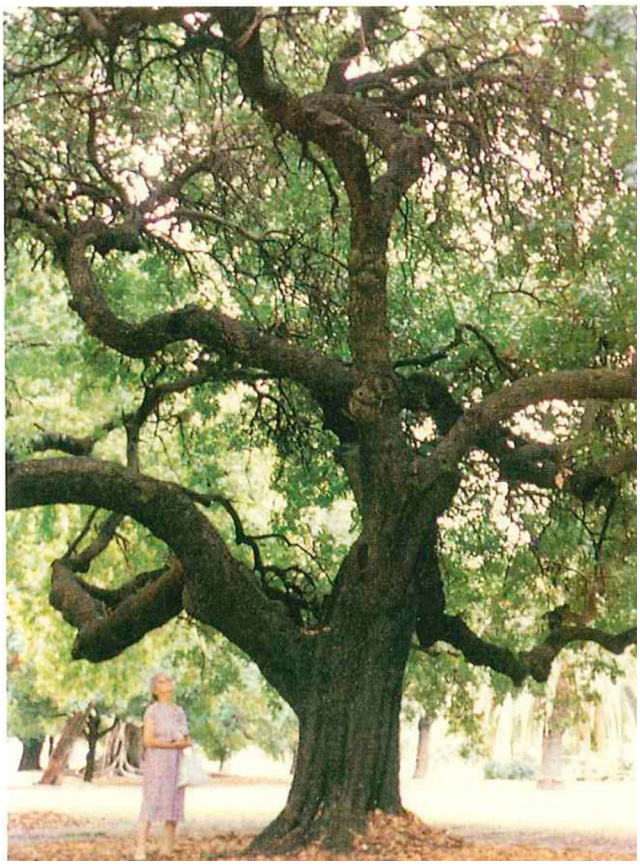
Pioneer: Black locust *(Robinia Pseudoacacia)*.
Kew Gardens, England,
(photo: Claire Everette)

Fruit: Moreton Bay fig *(Ficus macrophylla)*.
This "select" tree bears large, tasty fruit.
Perth, Western Australia.

Fruit: Irish strawberry *(Arbutus unedo)*.
Can also be maintained as an evergreen hedge.
Perth, Western Australia.

Nuts: chestnut tree *(Castanea sativa)*.
Manjimup, Western Australia.

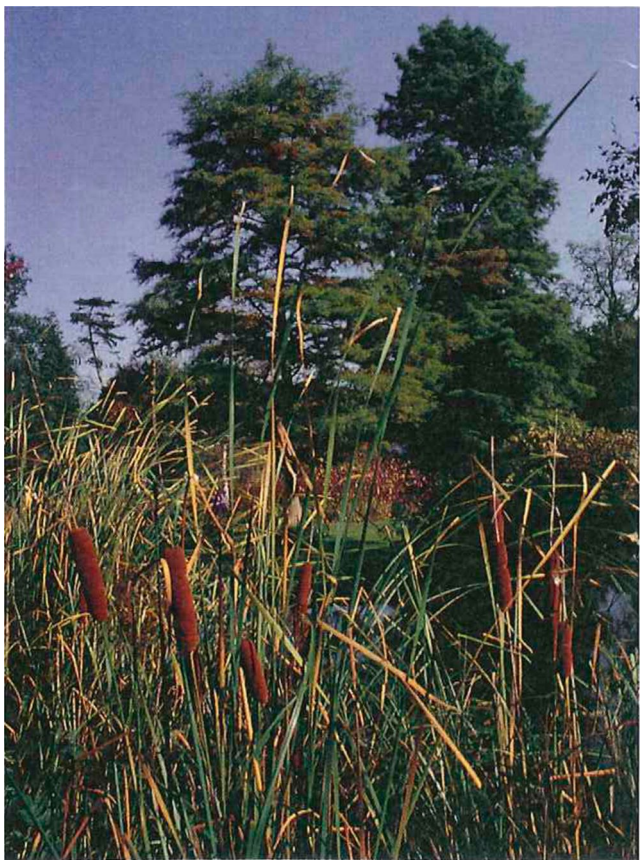
Holm oak *(Quercus ilex)*. Acorns are eaten by stock and humans.
It is a very hardy, evergreen, fire retardant.
Kew Gardens, England, (photo: Claire Everette)



Utility: carob tree *(Ceratonia siliqua)*
Perth, Western Australia.

Ivy *(Hedera sp)*. Planted over building to insulate and protect from fire.
The door leads to the office where most of this book was
created (using solar electricity).
Nannup, Western Australia.

Agave sp. Tolerant of alkaline soils and arid conditions. A good barrier fence plant and fire retardant. The commercial source of sisal fibre and some species are made into tequila.
Nannup, Western Australia.



Bullrush *(Typha sp)* with *(Taxodium distichum)* in the background.
Longstock, England, (photo: Claire Everette)

Utility: European beech *(Fagus sylvatica)*. Ancient hedge. Note that the trunks have pleached together forming one living organism.
Winkworth Arboretum, England, (photo: Claire Everette)

Pride of Madeira, *(Echium candicans)* will tolerate: coastal; windswept; alkaline sites and is an excellent early spring bee forage plant.
Stanley, Tasmania, Australia.

Water chestnut *(Eleocharis dulcis)* growing in pond, with taro *(Colocasia esculenta)* growing on banks.
Busselton, Western Australia.

THE FRUITS

FIGS *(Ficus spp)*

Family: MORACEAE

A large genus of about 600 species all from tropical to sub tropical regions, and often found in rainforest conditions, although many extend into arid areas. The fruits are pollinated by tiny wasps and many of the figs produce fruit year round to support these wasps. Even the common fig, *Ficus carica* tries to hold onto some fruit when it goes into dormancy in the temperate winters. A sprinkling of other *Ficus spp* among the more flavourful *Ficus carica* should ensure good populations of these wasps. The seed from these species are readily transported in nature by fruit bats and birds, which feed on the fruit. The fruits are generally good poultry feed. Far from being good companions to other trees, some species in the genus (including curtain fig, Moreton Bay fig and strangler fig) can start growing in the canopy of a host tree and then commence sending down aerial roots, ultimately engulfing the entire tree. The *Ficus spp* are generally considered good fire retardant trees. The milky latex that exudes from the broken leaf, stem or unripe fruit is used to treat infections such as ringworm and warts.

It has been reported that the Perth zoo grows various *Ficus spp* as stock fodder, especially to provide roughage for large herbivores such as elephants and rhinos.

Ficus carica (fig)

The fig is one of the most ancient plants in civilisation, and exists in as many as 700 varieties of the species. It is a deciduous tree and can grow to a height of 5 - 10 m, with a spread of up to 25 m, although most cultivars tend to be smaller. It grows best in warm temperate and sub - tropical regions and is frost tolerant to - 10°C. Very young trees may be injured by early or late frosts, so should be protected. Figs can live for 100 years and begin to bear fruit at 2 - 3 years.

Fig trees do well in a wide range of soils, although they dislike alkaline or salty soils. The soil should not be too rich in nitrogen and periodic applications of lime are beneficial. They are tolerant of drought, but produce better quality fruit when water is plentiful. They often produce a better crop of fruit if the roots are restricted, and for that reason it is a good tree for container growing in small gardens.

The fruits are produced singly or in pairs in the leaf axils, and vary considerably in shape and skin colour between varieties. The wild fig depends for pollination on a tiny wasp, but some cultivated varieties or hybrids require no pollination and produce only female flowers. In some climates, figs produce two crops, one in the early summer and one in late summer to early autumn. The first crop tends to produce larger fruits, the second crop smaller but more numerous fruits.

Little pruning is required, unless the tree is to be kept as a dwarf. Pruning consists mainly of cutting out dead, deformed or weak branches. The tips of young shoots can be pinched out to ensure that they make good, strong growth, as the fruit only comes to maturity on new or recently ripened wood. Figs can also be trained to grow up against walls or along fences.

Propagation is by layering or cuttings. Layers should root in a season and should be detached from the parent tree when the pot into which they have been led is filled with roots. Cuttings should be selected from short - jointed shoots of the previous years growth, and taken in spring. The 15 - 25 cm cuttings do best in sandy soil in the warmth.

Figs can be eaten fresh, frozen or dried, the sugar content rising from 12% to 50% on drying. The best way to dry figs is to let them dry partially on the tree and drop naturally to the ground. They can then be dried further on trays.

Nutritional composition of **fresh** fig per 100 grams of edible portion is: Water - 77.5%, Energy - 80 calories, Carbohydrate - 20.3 g, Fat - 0.3 g, Protein - 1.2 g, Ash - 0.7g, Calcium - 35 mg, Potassium - 194 mg, Sodium - 2 mg, Magnesium - 20 mg, Iron - 0.6 mg, Phosphorous - 22 mg, Iodine - 0.004 mg, Bromine - 0.18 mgs, Vitamin A - 80 I.U, Thiamin - 0.06 mg, Riboflavin - 0.05 mg, Niacin - 0.4 mg, Ascorbic acid - 2 mgs and the digestion time is 2.25 hours.

Nutritional composition of **dried** fig per 100 grams of edible portion is: Water - 23%, Energy - 274 calories, Carbohydrate - 69.1 g (about 50g is dextrose), Fat - 1.3 g, Protein - 4.3 g, Ash - 2.3g, Calcium - 126 mg, Potassium - 640 mg, Sodium - 34 mg, Magnesium - 71 mg, Iron -3.0 mg, Phosphorous - 77 mg, Chlorine - 100 mg, Sulphur - 270 mg, silicon 240 mg, Vitamin A - 80 I.U., Thiamin - 0.1 mg, Riboflavin - 0.1 mg, Niacin - 0.7 mg, Ascorbic acid - 2 mgs and the digestion time is 2.5 hours.

Figs are used medicinally for their mild laxative effect. Often they are mixed with senna, rhubarb, and other stronger laxatives. Demulcent decoctions are prepared from figs and used in the treatment of catarrhal infections of the nose and throat. Figs can be roasted and split into two and the soft pulpy interior provides a poultice for dental abscesses, gum boils, circumscribed tumours and boils. The milky juice of the fig is applied to warts. This causes them to dry and fall off.

The wood is porous and of little use.

Cultivars

Brown Turkey	Medium sized fruit with mahogany brown skin tinged purple, and has few seeds. It has a rich flavour and is best eaten fresh. Not good for canning or drying. The tree is cold hardy.
Celeste	Violet coloured, with light coloured flesh, which is firm, juicy and sweet.
Col di Signora Bianca	Thick yellowish white skin with dark red, syrupy flesh.
Conadria	A vigorous tree, adapted to warmer climates. Medium sized, firm fruit with greenish yellow skin, blushed purple. A very sweet fig and the best variety for drying.
Desert King	Widely adapted, but does best in cooler climates. Bears a large fruit with a dark green skin, and of excellent quality. Often produces a second crop in warmer areas.
Genoa (White Genoa)	Best adapted to cooler areas and one of the hardiest of all varieties. Medium sized fruit with whitish skin. Good quality and flavour, excellent for fresh eating.
Kadota	A vigorous tree which does best in hot climates. Bears a medium to large fruit with yellowish green, tough skin. The flavour is rich and sweet and is a popular variety for commercial canning.
Mission (Black Mission)	A dependable variety with an excellent flavour. Has a large fruit with purplish black skin, which can be eaten fresh dried or canned.
Osborn Prolific	Prefers cooler areas. A medium sized, purplish brown fruit with a strong flavour.
Texas Everbearing	Good for areas with a short growing season. Medium to large, good quality fruit with a purplish skin.

Ficus macrophylla (Moreton Bay fig, figwood, black fig)

A tall (to 50 m), evergreen forest tree of the tropical and sub - tropical rainforests of eastern Australia and also New Guinea. Given the space, it is a spreading tree often twice as wide as it is tall, with a wide buttressed trunk.

It prefers a deep, moist, fertile, alluvial soil in rainfalls between 1000 -1700 mm. It has been planted and grows very well in coastal sands in Western Australia almost right to the sea in rainfalls around 700 mm. Moreton Bay figs were planted extensively around Perth as park trees and also as street trees but have fallen into disfavour for the latter because their root system destroys paths, roads, drains, fences and buildings.

The fruit is very variable but in some individuals, can be outstanding in size and flavour and quite reminiscent of *Ficus carica.* The Australian Aborigines made a string from the bark fibres which they used to manufacture dilly bags and fishing nets. The timber is open grained, easily worked and dresses with a mild sheen reminiscent of cedar.

MULBERRIES *(Morus spp)*

Family: MORACEAE

Mulberries form small to medium sized, long lived (300 years), deciduous trees. These easily propagated and transplanted trees are both hardy and drought resistant. They are also frost tolerant and well suited to cool areas. They are tolerant of shade and are suited to most soils and sites.

They are heavy (19-24 t/ha), regular, bearers of fruit. The fruit is delicious eaten raw and can be dried and powdered to produce a flour suitable for cooking. The fruit is used as a self harvest pig food supporting 2 - 3 pigs per tree at 86 trees per ha, for the fruiting season (60 days for Hicks variety which has the longest fruiting season of all). It is also an excellent self forage plant for poultry.

The tree coppices readily and the timber is good for tool handles and fence posts. The leaves are nutritious and can be fed to livestock including silkworm.

They are considered a good companion plant for grapes , for which they also form a trellis.

Morus alba (white mulberry)

This tree is named after its white fruit. It is native to China where the leaves were traditionally fed to silkworms. It is a fast growing (to 25 m) shade tree and tolerates a wide range of conditions, although it prefers deep soil, good drainage and full sun.

The leaves are very palatable to livestock and are nutritious (crude protein - 15.1%, crude fat - 5.7%, crude fibre - 13.7%, nitrogen free extract - 50.3%, calcium - 1.95%, phosphorous - 0.4%.) If properly managed by annual pruning, it can be an important source of fodder and on well drained soils is one of the best trees for cultivation.

The dried fruit is used for human food in Afghanistan where it is ground and mixed with ground almonds as a staple (analysis of dried mulberry - : total solids - 94.81%, ash - 2.75%, protein - 2.59%, sucrose - 1.2%, invert sugar - 70.01%, crude fibre - 2.65%, starch absent).

The wood, especially the sapwood, has been used commercially in the manufacture of sporting goods. The wood is also used for house building, furniture, tool handles (can be pruned to shape when young), turnery, bent parts of carriages and carts, spokes, shafts, etc. The bark is used in China and Europe for making paper and the bark yields a fibre suitable for use in the textile industry.

Morus nigra (black mulberry)

Also known as the English mulberry or Persian mulberry (it is native to Persia), this species is a small rounded tree (seldom more than 12 m), with a broad rounded crown. The timber is prized for turnery and carving.

Morus rubra (red mulberry)

Native to eastern and central United States. Ripe fruits are eaten fresh or made into preserves, jellies and pies. Dried fruit is mixed with almond meal to make a confectionery. The young shoots and unfolded leaves are eaten raw or boiled.

PERSIMMON *(Diospyros kaki)*

Family: EBENACEAE

Other common names are Chinese persimmon and kakee. A deciduous, round - headed tree growing to a height of 5 m. It has strikingly coloured autumn foliage, making it an attractive ornamental tree as well as a fruit producer. Persimmons prefer a medium loam soil, but will grow well in most ordinary soils as long as they are kept moist. It does not thrive in dry or acid soils, but will withstand a certain amount of waterlogging. The mature plant is frost hardy to - 10°C.

The fruit is orange in colour, slightly larger than a tomato, and has to be fully ripe before being eaten. The unripe fruit is very astringent and contains tannic acid. It can be eaten either fresh or dried, or can be made into jams or jellies. There are different cultivars available, some being astringent varieties, others being non - astringent. Persimmons begin to bear fruit when about 3 years old (grafted trees or trees grown from cuttings).

Nutritional composition of persimmon per 100 grams of edible portion is: Water - 78.6%, Energy - 77 calories, Carbohydrate - 19.7 g, Fat - 0.4 g, Protein - 0.7 g, Ash - 0.6 g, Calcium - 6 mg, Potassium - 174 mg, Sodium - 6 mg, Magnesium - 8 mg, Iron - 0.3 mg, Phosphorous - 26 mg, Vitamin A - 2710 I.U., Thiamin - 0.03 mg, Riboflavin - 0.02 mg, Niacin - 0.1 mg, Ascorbic acid - 11 mgs and the digestion time is 3.75 hours.

They are propagated from seed, by grafting or from cuttings. Seedling trees grow tall, and make good shade trees. The seedlings however, tend to be variable and often do not grow true to type. Persimmons need plenty of water during the growing season, and benefit from mulching, as this helps to keep the roots moist. Minimum spacing between plants is 5 m. They are dioecious, requiring male and female plants, although in some cases, male and female flowers are found on the same tree. The female flowers will produce fruit if not pollinated, but these will be seedless and will take longer to ripen. Under some conditions, fruiting will be biennial.

Other species of persimmons available are *Diospyros virginiana,* (American persimmon) and *Diospyros lotus* (date plum). The fruits of the American persimmon are smaller, usually yellow, but can also be dark red or purple - red. The date plum fruits are smaller still (1 - 2 cm), and purple - black when ripe. *Diospyros dignya* (black sapote or chocolate pudding fruit), is an evergreen native of Central America, having a very sweet fruit with chocolate brown flesh.

Nutritional composition of the American persimmon per 100 grams of edible portion is: Water - 64.4%, Energy - 127 calories, Carbohydrate - 33.5 g, Fat - 0.4 g, Protein - 0.8 g, Ash - 0.9 g, Calcium - 27 mg, Potassium - 310 mg, Sodium - 1 mg, Iron - 2.5 mg, Phosphorous - 26 mg, Ascorbic acid - 66 mgs and the digestion time is 3.75 hours.

OLIVE *(Olea europaea)*

Family: OLACEAE

A hardy, evergreen tree, growing to a height of 25 - 30 m, the olive is widely distributed throughout the world especially in Mediterranean regions. It needs full sun and a long, comparatively dry season, with some winter chilling for good fruit production. The tree is frost hardy to about - 9.5°C, although the fruit is damaged below - 2°C. It prefers deep, rich, well - drained soil, but can tolerate poorer, shallower soils. Although the olive is very drought tolerant, occasional deep watering in arid climates increases fruit size and production. It will withstand strong winds, making it a useful species for windbreak, and has some salt resistance.

The olive tree is self - pollinating and will bear fruit after about 5 years and can continue for more than 2000 years. As with many trees, a heavy crop one year will often be followed by a light crop the next, although this tendency can be overcome by thinning the fruit. Average yield is about 4.8 tonnes/ha, the fruit having an oil content of between 18 - 25%. Between 225 - 270 litres of oil of all grades is usually obtained from pressing 1 tonne of olives. The fruits are green at first, but ripen to black during the winter months. They can be picked either green or black for both pickling and oil production.

Nutritional composition of the pickled green olive per 100 grams of edible portion is: Water - 86%, Energy - 116 calories, Carbohydrate - 1.3 g, Fat - 12.7g, Protein - 1.4 g, Ash - 6.4 g, Calcium - 61 mg, Potassium - 55 mg, Sodium - 2400 mg, Magnesium - 22 mg, Iron -1.6 mg, Phosphorous - 17 mg, Vitamin A - 300 I.U. and the digestion time is 1.75 hours.

Olive trees may be propagated by seed or cuttings, although raising from seed is slow, often taking up to a year to germinate. The hard stones can either be cracked or scarified to speed the process. The seedlings should then be grafted. Cuttings can be taken in summer. Strong shoots, 10 - 15 cm long are stripped of leaves to half their length and the bare portion inserted into sandy soil. Best results are obtained using bottom heat in a greenhouse. Most cultivated varieties are grafted onto seedling stock and as many as 5 varieties can be grafted onto one rootstock. Olives need little or no fertiliser. Corrective pruning may sometimes be required.

Cultivars

Ascolano	Has large fruit with good oil content but less than "Mission" or "Manzanillo". Fruit is tender and needs careful handling. Good processing variety.
Barouni	Thrives in heat.
Manzanillo	A spreading tree with larger fruit than "Mission" and fruit ripens earlier. Average oil content. Good eating olive.
Mission	A tall variety with medium sized, blue - black fruit. Average oil content. More cold tolerant than some other varieties.

Sevillano	Bears the largest fruit but with the least oil content. Fruit has a woody texture. Not a good variety for processing unless size is the main criterion.
Verdale	Large fruited. Good processing variety.

Processing

Olive oil: olives can either be picked green or left until they are fully ripe and starting to become wrinkled. The best quality oil is obtained from green olives, but a greater yield is produced from those allowed to ripen. The olives should then be dried on racks for a week or ten days, turning frequently, or in a food drier. Press the dried olives in an olive or cider press, but do not squeeze hard enough to crush the pits as the oil is of inferior quality and used to make soap. Strain the juice through cheesecloth into glass jars and allow it to separate from the remaining solids. Over the next 2 - 3 months the oil should be siphoned off as sediment builds up. This should be done every 2 weeks for as many as 5 times. Once the oil is clear it can be poured into sterilised jars and sealed. Refrigerate once opened. Pickling olives: Olives can be picked either green or tinged black for pickling, depending on the variety. It is important that the fruit be handled carefully, as they bruise easily. The processing removes the unpalatable bitterness from the olives. Slitting the skins or pricking with a fork will help to speed the process.

Method: soak olives in fresh water, ensuring that they are fully immersed and rinsing every few days. Black olives should be rinsed and soaked for a week, green olives for two weeks. Then rinse olives and store in an airtight jar in a salt - water solution. The brine should be just strong enough to allow an egg to float in it. Fresh herbs such as fennel can be packed between the olives and the lid to ensure that they are fully immersed. The olives should be left in this solution for at least a month and can be left for up to 2 years. After thoroughly rinsing, the olives can then be flavoured with a herb and garlic dressing. Place them in a jar with plenty of garlic and herbs such as marjoram and thyme. Fill the jar with 3/4 boiled and cooled water, 1/4 cider or white wine vinegar and a thin layer of olive oil on top. Shake and leave for a month.

JUJUBE *(Ziziphus spp)*

Family: RHAMNACEAE

***Ziziphus jujuba, syn. Ziziphus vulgaris* (jujube)**

Also known as the Chinese red date, the jujube is a deciduous tree. The origin of the plant is obscure because it has been in cultivation for so long. It may be a native of China or India although there is a good argument for it being native to the Mediterranean region, probably Syria. It has an upright habit and grows to 9 m tall. The branches tend to droop under the weight of the fruit.

It prefers full sun. It is well suited to deep, alkaline and saline soils, and drought conditions. It is tolerant of, but does not favour waterlogging or clay soils.

Damaged roots can cause the tree to send out suckers.

The fruit is light green to reddish brown and rich in vitamin C. When eaten fresh it has a crisp texture with a flavour between apple and date. It dries well and is a saleable product. The fruit is also boiled with millet and rice, stewed, baked, pickled, or used as a coffee substitute. It can also be used in puddings, cakes, breads, jellies, soups, sweetmeats, etc. Jujube flour is made into a miso - like fermented hot pepper and soyabean paste in Korea. The dried fruit is often used in fish dishes and soups. A sweet made from the fruit is the original jube.

Nutritional composition of the **fresh** jujube per 100 grams of edible portion is: Water - 70.2%, Energy - 105 calories, Carbohydrate - 27.6 g, Fat - 0.2 g, Protein - 1.2 g, Ash - 0.8 g, Calcium - 29 mg, Potassium - 269 mg, Sodium - 3 mg, Iron - 0.7 mg, Phosphorous - 37 mg, Vitamin A - 40 I.U., Thiamin - 0.02 mg, Riboflavin - 0.04mg, Niacin - 0.9 mg, Ascorbic acid - 69 mgs.

Nutritional composition of the **dried** jujube per 100 grams of edible portion is: Water - 19.7%, Energy - 287 calories, Carbohydrate - 73.6 g, Fat - 1.1 g, Protein - 3.7 g, Ash - 1.9 g, Calcium - 79 mg, Potassium - 531 mg, Iron - 1.8 mg, Phosphorous - 100 mg, Ascorbic acid - 13 mgs.

The fruits are soothing to the throat and the juice is used in decoctions for treating colds and sore throats. They are also used in pharmacy to sweeten medicines.

Ziziphus mauritiana (Indian jujube)

This tree is more tropical and withstands severe heat, drought and frost. The rainfall requirements are as low as 300 - 500 mm, but it does occur in areas of rainfall up to 2000 mm.

It has a smaller fruit than the jujube. The fruits are eaten fresh, dried, powdered into a meal, boiled with rice, or used in preserves, jellies, sauces and beverages. It is also made into a liqueur (crema de ponsigne) and the dried fruits are mixed with salt and tamarind pulp to make a condiment. Young leaves are cooked and eaten in Indonesia.

The leaves are fed to the tsar silkworm. It can also be used as a host to lac insects for the production of shellac. The foliage is considered good fodder for cattle, camels and goats. The bark can be used for tanning. The limber is fine grained, hard and strong with a reddish colour. It works well and takes a good polish. It is considered a good firewood tree having a specific gravity of 0.93 and a heat content of almost 4,900 kcal per kg.

Ziziphus nummularia

A salt tolerant species which has the potential to serve as a rootstock for more productive species such as *Ziziphus jujuba,* in saline conditions. It is a native of India and Pakistan and is both a good browse plant and a good firewood, the heartwood having a calorific value of 4400 kcal per kg.

Ziziphus spina - christi (Christ thorn)

It is known as the Christ thorn because it is believed to be the tree used for the crown of thorns which Jesus was made to wear. It is a spiny bush or tree that strongly resists both heat and drought. It is native to vast areas of Africa and the eastern Mediterranean.

The red or dark brown wood is used for spear shafts, posts, roofing beams, and household utensils. It is reported to be termite proof and a good cabinet making wood.

The mealy fruits have a flavour somewhat resembling dried apples. Sheep and goats can survive on the fruit and camels on the leaves. It prefers deep alluvial soils.

LOQUAT *(Eriobotrya japonica)*

Family: ROSACEAE

Other common names are Japanese loquat and Japanese medlar. Originally from central China, the loquat is a small, evergreen tree which can reach 6 - 9 m in height, although under less favourable conditions it will often be smaller than this (about 3 m). Although the tree itself is fairly frost hardy (to - 10°C), it does not fruit well in cold climates. Winter temperatures below - 5°C will prevent it bearing fruit, as the flowers are borne at a cold time of year, at the beginning of winter. It will grow in a variety of soils, but does best in a light, deep, loamy soil, which is kept moist. It does not like too much lime in the soil. It is moderately drought and wind tolerant, and can be used as a hedge or windbreak. It is also tolerant of salt spray. An excellent shade tree. Many fine cultivars are now available.

The fruit are oval in shape (5-6 cm), and yellow or orange in colour, with a sweetly perfumed, softly acid flesh. There is usually one large seed or sometimes two in each fruit. The fruits mature in spring and early summer. They are best eaten fresh, but can also be made into jams and wine. They are a refreshing, easily digested fruit, though not highly nutritious.

Nutritional composition of the loquat fruit per 100 grams of edible portion is: Water - 86.5%, Energy - 48 calories, Carbohydrate - 12.4 g, Fat - 0.2 g, Protein - 0.4 g, Ash - 0.5 g, Calcium - 20 mg, Potassium - 348 mg, Iron - 0.4 mg, Phosphorous - 36 mg, Vitamin A - 670 I.U., Ascorbic acid - 1 mg.

Thinning the fruit will result in a greater fruit size. The tree also has some potential as animal forage.

Loquats can be grown from seed and by grafting or cuttings. They will sometimes self sow around the tree. Usually, however, the trees are grafted or budded, the rootstock often being a quince, as this both dwarfs the plant and hastens an early fruiting. Grafted trees will fruit at about 3 years old. They should be planted at a minimum spacing of 4 m. Cross pollination is an advantage.

ACEROLA, BARBADOS CHERRY *(Malpighia glabra)*

Family: MALPIGHIACIAE

Other common names are West Indian cherry, native cherry.

A very attractive, slow growing, evergreen shrub to a height of about 6 m. The leaves are a glossy dark green. It is a very tough and versatile plant, which will grow in any soil under almost any conditions, although it does prefer a moist soil and responds well to mulching. The tree does well on limestone, marl and clay as long as it is well drained. Lime should be added to acid soils. It is moderately drought and salt spray tolerant and is frost hardy to - 2°C.

Young trees need regular watering, but once established should only need watering in drought. The tree is susceptible to root knot nematode, especially in sandy soil.

The plant should begin to fruit after about 4 years. The fruit is cherry - like, 1.25 - 2.5 cm in diameter, red to crimson and almost black when ripe. The flesh is the same colour, soft and juicy and sweet when well grown. It is very high in Vitamins C and A. The pink flowered variety is the most productive. As well as being eaten fresh, it can also be used in drinks and can be dried. Wine made from the Barbados cherry was found to retain 60% of the ascorbic acid.

It is a good animal forage. It makes a good hedge or pioneer species.

Nutritional composition of the Barbados cherry per 100 grams of edible portion is: Water - 81.9 - 91.10%, Energy - 59 calories, Carbohydrate - 6.98- 14.0 g, Fat - 0.18 - 0.1 g, Protein - 0.68 - 1.8 g, Ash - 0.77 - 0.82 g, Calcium - 8.2 - 34.6 mg, Iron - 0.17 - 1.11 mg, Phosphorous - 16.2 - 37.5 mg, Vitamin A - 408 - 1000 I.U., Thiamin - 0.0.024 - 0.040 mg, Riboflavin - 0.038 - 0.079 mg, Niacin - 0.34 - 0.526 mg, Ascorbic acid ranges from 4,500 mg in the green fruit, 3,300 mg in the medium ripe fruit to 2,000 mg in the very ripe fruit.

The bark contains tannin (20 - 25%) and can be used for tanning. The wood is hard and heavy. The wood will not burn unless totally dried. The juice of the fruit is gargled to relieve sore throat. The fruit is beneficial for coughs, colds, diarrhoea, dysentry and liver complaints. The leaves and petioles have tiny stinging hairs which can cause skin irritation.

The Barbados cherry can be grown from seed and usually grows true to type. It can also be propagated by grafting or from cuttings.

PAPAYA *(Carica papaya)*

Family: CARICACEAE

Other common names are tree melon and pawpaw (not to be confused with *Asimina triloba).* The papaya is a large herb or softwood tree, growing to a height of 10 m, although it is seldom allowed to grow as tall as this as the trunk tends to break and the fruit is more difficult to harvest. It is susceptible to the cold and cannot tolerate temperatures lower than 1°C. Mature trees are slightly more tolerant of light frosts but a sunny, sheltered position is preferable. It will grow in most soils as long as they are well drained and rich in humus. Papayas do not like acid soils, and are only moderately drought tolerant. They are fairly short lived plants, and have been used as pioneer species.

The fruits, which are produced from January to June, are large and oval in shape. They may be produced on seedling trees from as early as one year old, but will only be produced for a period of 3 - 4 years. When ripe, the skin is a yellow - orange colour and soft to the touch. Papaya flesh is soft, juicy and orange - yellow or salmon - pink in colour. It contains numerous brown - black seeds which can be used as a spice. The fruit is best eaten fresh, but can also be dried or made into jams. It is rich in calcium and Vitamins A and C. The fruits can be boiled and eaten as a vegetable when still unripe.

Nutritional composition of the papaya per 100 grams of edible portion is: Water - 88.7%, Energy - 39 calories, Carbohydrate - 10 g, Fat - 0.1 g, Protein - 0.6 g, Ash - 0.6 g, Calcium - 20 mg, Potassium - 234 mg, Sodium - 3 mg, Iron - 0.3 mg, Phosphorous - 16 mg, Vitamin A - 1750 I.U., Thiamin - 0.04 mg, Riboflavin - 0.04 mg, Niacin - 0.3 mg and Ascorbic acid - 56 mgs.

The sap of the papaya is milky white, and contains an enzyme, papain. This sap is made into chewing gum, medicine (it is an aid to digestion), toothpaste arid meat tenderisers. Meat can be wrapped in a bruised papaya leaf before cooking to make it more tender. The tree is also a moderately useful bee forage plant.

Papayas are grown mainly from seed, but can also be grown from cuttings or grafted. Minimum spacing between plants is 2 m, and a pollinator is necessary. There are three types of flowers, male, female and hermaphrodite, all occurring on separate plants. Plants of the bisexual type are more suitable for tropical areas, whereas monosexual plants do better in cooler areas. One male plant to 9 females is sufficient. After the fruit has set, it is best thinned to 2 fruits per node.

HIGHLAND PAPAYAS *(Carica spp)*

Family: CARICACEAE

There is a range of papayas from the Andes with differing characteristics. They are all evergreen trees resembling, to some extent, the tropical papaya. They can be abundant bearers of fruit and all papaya fruit contains the enzyme papain.

They are much more tolerant of cold conditions than the tropical papaya. They are generally very variable within each species, some having extremely edible fruits while others are barely edible. None seem to tolerate waterlogged conditions.

Carica pubescens (chamburo)

This is the most common and widespread species of highland papaya. It is grown commercially in northern Chile and can be found in most backyards in eastern Peru. It is tolerant of a wide range of conditions from wind swept, dry, open plateaus to humid, shaded forests.

Most plants are dioecious and require a male and a female to set fruit. They are usually propagated from seed, although individuals with desirable characteristics can be propagated from cuttings. They are fairly fast growing, often bearing in their second year.

The fruit is very variable, some can be eaten out of hand but most are so high in papain that they have to be cooked to be eaten.

Carica goudoutiana (papayuelo)

A native of humid forests of Columbia, this usually small species can sometimes grow up to 8 m. The fruit varies from delicious, almost apple flavour, to being almost inedible even when cooked.

Carica monoica (col de monte)

This vigorous grower rarely exceeds heights of 1 - 3 m. It prefers areas of high rainfall and mild winters.

The fruits are often eaten raw in fruit salads. When cooked with lemon and sugar they are said to taste like stewed apricots. They are also dried, candied and frozen. The common name 'Col de Monte' means mountain cabbage and refers to the fact that the young seedlings and mature leaves are cooked as greens.

It is generally self - pollinated and the seed usually produces true to the parent. It hybridizes easily with chamburo and the offspring often bear heavily and have good fruit.

Carica stipulata (siglalon)

This fast growing, spiny and occasionally branched tree grows to 8 m and is native to southern Equador. The plant is dioecious and requires a male and female to produce fruit. It can bear fruit for about twenty years. The small fruit is very high in papain and is not normally eaten raw.

Carica pubescens x Carica stipulata (babaco)

Rarely exceeding 2 m, the babaco is actually a hybrid which is propagated from cuttings. There seems to be a large variation in individuals which are claimed to be babaco. The plant is self fertile and produces an abundance of fruit (100 ton per hectare is a commercial standard).

PEPINO *(Solatium muricatum)*

Family: SOLANACEAE

"Pepino dulce" is Spanish for sweet cucumber and this was the name given to this fruit. The English abbreviation of pepino simply means cucumber, so is actually quite meaningless. The name however has stuck. In Peru it is called cachun.

It was possibly a native of Columbia but the exact origin of the plant is not known as it no longer exists in the wild. It may even be a natural hybrid of *Solatium basendopogon* a rather rare native of Peru.

The plant varies in habit from a trailing vine or a climber, to an erect shrub, which usually needs support. It easy to establish in most situations and makes a good nurse crop in establishing orchards. It is frost tender and prefers full sun to partial shade.

The fruit grows to about 200 mm in diameter and has a flavour reminiscent of rock melon (honeydew). It is easily made into a delicious wine.

It grows easily from cuttings and in a year one plant can be divided into hundreds.

TAMARILLO *(Cyphomandra betacea)*

Family: SOLANACEAE

The other common name for tamarillo is tree tomato. It is a native to the temperate Andes of South America but is known today, only as a domestic plant. It is ideally suited to small gardens in tropical and sub tropical climates, although it will grow in cooler areas, provided it is grown in a sunny, sheltered location. It is an erect, shrubby, fast growing evergreen reaching a height of 4 m. It is easy to grow, but fairly short lived. Tamarillo needs a rich, moist, well drained soil as it will not tolerate either waterlogging or drought. It is also very shallow rooted, so heavy mulching is recommended. If the roots become too dry or damaged in some way, the fruits will not mature, but will fall off. It is slightly frost tolerant (to - 2°C).

The fruits are egg shaped, about 5 cm long and either yellow, red or dark red, depending on the variety. The yellow fruits are the sweetest, the red ones having a harsher, more acid flavour. They are best eaten fresh, but can also be made into jams, jellies and preserves. The skin is easily removed if the fruit is dipped in hot water.

Nutritional composition of the tamarillo per 100 grams of edible portion is: Water - 82.7 - 87.8%, Fat - 0.0. - 1.28 g, Carbohydrates - 10.3 g, Protein - 1.5 g, Ash - 0.61 - 0.84 g, Calcium - 3.9 - 11.3 mg, Iron - 0.66 - 0.94 mg, Phosphorous - 52.5 - 65.5 mg (mostly in the seeds), Vitamin A - 540 IU, Thiamin - 0.038 - 0.137 mg, Riboflavin0.035 - 0.048 mg, Niacin - 1.1 - 1.38 mg and Ascorbic acid - 23.3 - 33.9 mg.

The tree has some value as bee forage.

The tamarillo can be propagated either from seed or cuttings. Plants grown from cuttings tend to be lower and bushier.

CAPULI *(Prunus salicifolia)*

Family: ROSACEAE

The capuli or capulin cherry, unlike true cherries, does not require a period of chilling to set fruit. It is an erect, semi - deciduous, very fast growing tree, reaching a height of 3 m in 12 - 18 months and eventually attaining 10 m at maturity. The capuli is believed to be native to Mexico but was introduced to the Andes by the Spanish. In the five hundred years that followed, the Andean people have adopted the capuli as a backyard tree. The selective breeding that has happened in that time is said to be considerable.

It is frost tolerant to about - 7°C, where some damage may occur. Because it does not require a cold spell to set fruit, it can be grown in much warmer conditions than conventional cherries.

The capuli fruit grows in bunches almost like grapes. The fruit is similar in appearance to that of the European cherry, with a dark purple skin and pale green, juicy flesh, with a flavour similar to wild cherries. Although the fruit is mostly eaten fresh in the Andes, it is also stewed, preserved, and made into jams and wine. The cherries are used as fillings for tamales in Mexico. A capuli tree will produce fruit 2 - 3 years after planting and does not require cross - pollination. In California, during an exceptionally mild winter, it has been known to produce two crops in the one year.

The capuli seems well suited to agro forestry. It has deep roots which bind the soil and in the Andes is interplanted with field crops such as lucerne, corn and potatoes.

In the Andes the wood is harvested after a few years for tool handles, posts, firewood and charcoal. After 6 - 8 years it yields an excellent timber which is used for guitars, furniture, coffins, panelling and other high value products. The wood is hard and resistant to fungal and insect attack.

The sapwood is yellow with touches of red, and the heartwood is reddish brown and fine grained and consequently fetches high prices on the market. The young branches are supple and strong and used to make baskets. The old roots are valued for carving tobacco pipes and figurines.

A syrup is made from the fruit to alleviate respiratory troubles. A leaf decoction is used as a febrifuge and to halt diarrhoea and dysentry. It is applied as a poultice to relieve inflammation. Leaf infusions are used as a sedative in colic and neuralgia, and as an antispasmodic. The pounded bark is employed as an eyewash.

Capuli trees can easily be propagated from seed, but the fruit quality of seedling trees tends to be variable.

WHITE SAPOTE *(Casimiroa edulis)*

Family: RUTACEAE

Originating in Mexico, the white sapote is not related to the sapotes, but belongs to the same family as the citrus. It is a tall, evergreen tree reaching a height of 10 - 15 m. Although a sub - tropical tree, it grows surprisingly well in cooler regions. It prefers good, well drained soil and is moderately drought and wind tolerant. Mature trees are frost tolerant to - 4°C, although young trees are likely to be damaged by frost.

The fruit are a greenish yellow colour when ripe, sweet in flavour, but sometimes with a slightly resinous taste. They are best eaten fresh but can also be made into jams, jellies or drinks.

Nutritional composition of the white sapote per 100 grams of edible portion is: Water - 78.3%, Fat - 0.03 g, Protein - 0.143 g, Ash - 0.48 g, Calcium - 9.9 mg, Iron - 0.33 mg, Phosphorous - 20.4 mg, Carotene - 0.053 mg, Thiamin - 0.042 mg, Riboflavin - 0.043 mg, Niacin - 0.472 mg, Ascorbic acid - 30.3 mgs and the digestion time is 3 hours.

The fruit is produced after about 3 years with grafted trees, or from 3 - 8 years from trees grown from seed. The fruit ripens mainly in early autumn. The plant is not always self - fertile, so it is a good idea to plant a few to ensure cross - pollination. The plant is a good bee forage.

The timber is fine grained, yellow, compact, moderately dense and heavy with medium strength, although not long term durable. It is resistant to most rots. The wood is sometimes used in Central America for furniture.

The fruit is claimed to induce sleep and extracts from the bark, leaves and seeds have been employed in Mexico as tranquillisers and sedatives. The extracts have been found effective in lowering blood pressure. The fruit is eaten throughout Mexico and Central America to relieve the pain of rheumatism and arthritis. In Costa Rica the leaf decoction is used to treat diabetes.

White sapotes grow easily from seed and are also produced by grafting. Seedlings should be pruned to encourage early branching, as they tend to become straggly. Many cultivars are now available. Minimum spacing of trees is 6 m apart.

LUCUMA *(Pouteria obovata, syn. Pouteria lucmo, Lucumo obovata)*

Family: SAPOTACEAE

Other common names; lucmo, lucuma, lucumo, lucmarucma, mamon.

Lucuma (pronounced luke - mah) is an attractive, evergreen, medium sized (8 - 15 m) tree native to the sub - tropical Andes where the tree blooms and fruits all year. The tree is adapted to fairly dry conditions and tolerates seasonal rains well but does not like waterlogging or extended humid weather. Lucuma can be killed by temperatures below - 5°C. As a rule of thumb it should grow wherever a lemon will grow. It will grow in most soil types provided that they are well drained. It yields best in deep alluvial soils which are rich in organic matter.

A single tree can produce up to 500 fruit each year. A fruit can weigh up to 1 kg and is rich in provitamin A (carotene), vitamin B_3 and is a good source of carbohydrate, calories and iron. The fruit falls to the ground when ready but then is stored in dry hay or sawdust until soft.

The fruit has smooth, bronze coloured skin and bright yellow or orange flesh. Although variable, the fruit can smell and taste like maple syrup. It is frequendy blended with milk to make milkshakes. The fruit can be dried and stored as a flour which keeps for years and which is added to other flours to make desserts. The fruit is a valuable chicken forage which promotes eggs with bright orange yolks. The wood is used in construction. The tree is grown from seed and cuttings, but grafting is reported difficult.

SAPODILLA *(Manilkara zapota, syn. Achras sapota)*

Family: SAPOTACEAE

Other common names: sapota, Santo Domingo apricot; marmalade plum; naseberry; nispero; dilly; chiku.

Large, slow growing, attractively shaped, evergreen tree, growing to a height of 5 - 18 m. A good shade or windbreak species. The tree starts to produce fruit when about 8 years old if grown from seed, 3 - 4 years if grown from grafts or cuttings. It prefers a moist, well drained soil with plenty of organic matter, but is adaptable to many soil types. The sapodilla is drought tolerant and also reasonably tolerant of salt spray, flooding and wind. Ideally it needs a warm climate and will tolerate very high temperatures, but mature trees will also tolerate temperatures as low as - 4.5°C. Young trees are likely to be killed by frosts.

The sapodilla fruit are usually produced in pairs, resemble a quince in shape and are a russet - brown colour when ripe. The fruit needs to be picked when it is fully ripe, as immature fruits contain tannin and a milky, inedible juice. The honey - coloured pulp is juicy, tender and very sweet. The seeds should be removed, as they are hooked and can lodge in the throat. The fruit can be used for jams and jelly making, and the young leaves are also edible.

Nutritional composition of the sapodilla per 100 grams of edible portion is: Water - 76.1%, Energy - 89 calories, Carbohydrate - 21.8 g, Fat - 1.1 g, Protein - 0.5 g, Ash - 0.5 g, Calcium - 21 mg, Potassium - 193 mg, Sodium - 12 mg, Iron - 0.8 mg, Phosphorous - 12 mg, Vitamin A - 60 I.U., Thiamin - trace, Riboflavin - 0.2 mg, Niacin - 0.2 mg, Ascorbic acid - 14 mgs.

Grafted plants or trees are preferable, as trees grown from seed, do not always grow true to type. Gross pollination is desirable, so it is advantageous if more than one tree is grown, but this is not essential. Minimum spacing between trees is 6 m.

The sapodilla produces a latex (called chicle), obtained by tapping the bark, which is used commercially as a basis for chewing gum in Central America. It also produces a good strong, durable, termite resistant timber which is used for furniture, banisters, cabinet making, bows, railway sleepers, flooring, tool handles and rulers. Some of the lintels and supporting beams in Mayan temples were made from the wood and are still intact in the ruins. It has some potential as animal forage.

PASSIONFRUIT *(Passiflora spp)*

Family: PASSIFLORACEAE

There are more than 40 edible species of passionfruit which are mostly tropical to subtropical, woody, fruiting vines that climb by means of tendrils. They will usually climb trellis or trees. Often they can inhibit the growth of the supporting tree by reducing the sunlight available to that tree, A way of overcoming this problem where it exists, is to provide a clump of trees so that the vine can spread out. The fruit is said to have been named by the Spanish who thought that the beautiful flowers reminded them of the passion of Christ. The fruit falls to the ground when it is ripe.

All of the passionfruit can be grown from seed although some can be very difficult at times. Fresh seed seems to have better chances. We have found that passing the seed through the digestive system of an animal first (duck or human both work) gives good results. Hydrochloric acid treatment has also given some results. Some grafted cultivars can be purchased but this is generally not necessary and often the rootstock can become a nuisance (see *P. caerulea*). Most of the passionfruit can also be propagated from cuttings.

Food Value of Edible Portion of Various Passionfruit

per 100g (based on Morton)

	P. edulis	*P. ligularis*	*P. mollissima*	*P. quadrangularis*
Calories	90	?	25	?
Moisture	75.1 g	69.9- 79.1 g	92.0 g	94.4 g
Protein	2.2 g	0.34-0.474 g	0.6 g	0.112 g
Fat	0.7 g	1.5- 3.18 g	0.1 g	0.15 g
Carbohydrates	21.2 g	?	6.3 g	?
Crude Fibre	?	3.2-5.6 g	0.3 g	0.7 g
Ash	0.8 g	0.87- 1.36 g	0.7 g	0.41 g
Calcium	13mg	5.6-13.7 mg	4mg	13.8 mg
Phosphorous	64 mg	44 - 78 mg	20 mg	17.1 mg
Iron	1.6 mg	0.58- 1.56 mg	0.4 mg	0.80 mg
Sodium	28 mg	?	?	?
Potassium	348 me	?	?	?
Carotene	700 I.U.	0 - 0.035 mg	?	0.004 mg
Thiamin	trace	0 - 0.002 mg	?	-
Riboflavin	0.13 mg	0.063 - 0.125 mg	0.03 mg	0.033 mg
Niacin	1.5 mg	1.42 - 1.813 mg	2.5 mg	0.378 mg
Ascorbic Acid	30 mg	10.8 - 28.1 mg	70 mg	14.3 mg

Passiflora edulis (purple passionfruit, granadilla)

This is by far the best known of the passionfruit and is native to Brazil. It is a subtropical, fairly densely growing, evergreen vine. There are also red and black variations of this species.

It prefers a moist, well drained, fertile, neutral to slightly alkaline soil. It withstands occasional light frosts, and prefers a sunny position. The fruiting season can be very long in warmer conditions and typically two crops are produced each year. In some parts of the world the two seasons extend into one another providing year round fruit.

The ripe, aromatic fruits are eaten raw, juiced, bottled, made into sauces, icing, cakes, jellies, etc. They are made into a soft drink and also a wine. An edible oil is extracted from the seeds which is comparable to sunflower and soybean oil. The seed contains about 12% protein and 50% fibre. The juice is used medicinally as a digestive stimulant and as a treatment for gastric cancer. Unripe fruit contain levels of cyanogenic glycosides which may have toxicological significance.

Passiflora edulis var. flavicarpa (yellow passionfruit)

This is a variation of the purple passionfruit which tends to be slightly less cold tolerant but is able to withstand *Fusarium* wilt and nematodes. It is said that this variety does better and is more fruitful if it is allowed to climb a tali tree rather than a trellis. Tall acacias are good for this purpose adding nitrogen fixing and long term timber to their functions.

There is said to be more juice to pulp compared with the purple passionfruit.

Passiflora moliissima (banana passionfruit, curuba, tacso)

Native to the Andes, this straggly, rampant vine can climb to cover trees. In the Andes it grows in mid level valleys between 1800 - 3200 m. In Hawaii (at elevations from 1200 - 1800 m) the vine is considered a pest because it strangles tall trees. It is cold tolerant down to - 2°C.

The aromatic fruit is long and elliptical in shape, yellow to orange in colour and the juice is thicker and stronger in flavour than the purple passionfruit. In the Andes it is considered the best tasting juice of all the passionfruit. It is made into a highly prized wine and also into a liqueur called *crema de curuba.* The fruit is eaten raw, used in fruit salads, ice cream, jellies and sauces. Lime juice is often added to the fruit to enhance the flavour.

Passiflora incarnata (maypop, apricot vine)

Native to south eastern USA, the maypop is said to be the most cold tolerant of the passionfruit. It dies back to the ground in winter and then shoots new growth in the spring. Disturbed roots also send out new shoots.

The fruit is eaten raw, and also made into jellies, jams, fruit salads and wine. The juice makes a refreshing drink. The leaves are eaten raw in salads and cooked as a green. The flowers are both made into a syrup and eaten as a vegetable.

A glycoside called passiflorine can be extracted from the plant and has pharmaceutical use as a sedative and a tranquilliser.

Passiflora herbertiana (Herbert River passionfruit)

A native of the Herbert River (northern Queensland, Australia), this evergreen, vigorous vine has an attractive flower. The edible oval fruit is about 40 mm long and green when ripe. The unusual burnt flavour is not enjoyed by all. The plant is capable of withstanding light frosts.

This is a difficult species to germinate. A double treatment with boiling water gives some results.

Passiflora caerulea (blue crown passionflower)

A vigorous and hardy species native to south Brazil and Argentina. The small fruits are edible and flavoursome but have little juice. Unripe fruits are boiled and eaten.
It is used as a rootstock for grafted purple passionfruit but the root suckers often escape and become a nuisance.

Passiflora ligularis (sweet granadilla)

Native to central Mexico, Central America and western South America, this vigorous climber can shade and kill all of its understorey. It is capable of climbing the tallest of trees. It is a subtropical species, able to withstand light frosts, but not extended periods below - 1°C.

The orange - yellow fruit contains a soft, translucent, perfumed pulp which is comparable to the purple passionfruit in flavour and quality although many people prefer to eat it with lime juice. The fruits are eaten fresh or used in drinks and desserts.

Passiflora quadrangularis (giant granadilla)

A native of tropical America, the giant granadilla is a fast growing vine climbing trees up to 45 m in the tropics. It prefers warm days and nights and cold winters have been known to kill well established vines. It requires a deep, fertile, moist, but well drained soil. Extremely alkaline soils have killed this plant.

The fruit is the largest of the passionfruits. It is pleasantly aromatic and melon - like and can grow up to 15 cm wide and 30 cm long. The flesh is eaten from the skin and is also used in fruit salads. It is cooked in sugar but is so bland that it requires lime or lemon juice as a flavouring. The unripe fruits are used in soups and eaten both steamed and boiled, usually with butter, nutmeg and pepper as a garnish. The juice is used in cold drinks and wines. The roots of old vines are eaten roasted or baked like yams.

The pulp contains passiflorine which if consumed in large doses can cause lethargy and drowsiness. The fruit is used medicinally as a preventative for scurvy and as a stomachic. The flesh has been used as a sedative for relief of headache, asthma, diarrhoea and dysentry, neurasthenia and insomnia. The seeds are cardiotonic, sedative and also narcotic in large doses. The leaf decoction is a vermifuge and is used for bathing skin problems. In liver complaints, poultices of the leaves are used. The root is used as a vermifuge, emetic and diuretic. It is used as a soothing poultice when powdered and mixed with oil.

Passiflora antioquiensis (Columbian passionfruit)

This plant is similar in appearance to the curuba except that the flower is red. It is not as cold tolerant as the curuba but the fruit is said to be juicier and of a better eating quality. They have a thick skin which can make pulp extraction difficult.

CHERIMOYAS *(Annona spp)*

Family: ANNONACEAE

The genus contains several closely related species, commonly referred to as the cherimoyas or custard apples.

Annona cherimola (cherimoya)

An Andean native, semi - evergreen tree, growing to a height of 9 m, but varies in habit from neat, erect and bushy, to tall and straggly. The cherimoya is said to be the best of several related species, but only fruits under specific conditions. While other species are likely to thrive best in the tropics, the cherimoya does best in warm areas outside the tropics. It also needs high humidity during the flowering period in order for the fruit to set properly. Young trees are susceptible to frost damage, but older trees are frost tolerant to about - 3°C. Cherimoyas do best in a deep, fertile, light - textured soil, but will also grow in a clay loam, as long as it is well drained. They do not thrive on shallow soils. It is moderately drought tolerant although prefers to be kept moist, and will withstand some salt spray

There are few natural pollinators for cherimoya and as the male and female structures on each flower do not coincide, hand pollination is common to ensure crops.

The fruit are green in colour, variable in size, and at first sight resemble a globe artichoke, although the scales are not separate but massed. The flesh is white, and the flavour is considered to be a cross between a pineapple and a strawberry. The seeds are numerous, black and brown. The fruits ripen in autumn and early winter and are best eaten fresh. The first crop of fruit is borne at around 3 years old for grafted trees, 4 years for seedling trees. The fruits mature at different times on the tree, and are best picked just before they are fully ripe.

Nutritional composition of the cherimoya per 100 grams of edible portion is: Water - 73,5%, Energy - 94 calories, Carbohydrate - 24.0 g, Fat - 0.4 g, Protein - 1.3 g, Ash - 0.8 g, Calcium - 23 mg, Iron - 0.5 mg, Phosphorous - 40 mg, Chlorine - 274 mg, Sulphur - 167 mg, Vitamin A - 10 I.U., Thiamin - 0.10 mg, Riboflavin - 0.11 mg, Niacin - 1.3 mg, Ascorbic acid - 9 mgs.

Cherimoyas can be propagated from seed, grafted or grown from cuttings. Seedling plants are variable, so it is wise to buy grafted trees. Some varieties need pollinators. *Annona senegatensis* is said to be a good pollinator for cherimoya.

Annona atemoya (custard apple)

Also known as bullock's heart, the custard apple is one of the deciduous species of cherimoyas and grows to a height of about 8 - 10 m. It is susceptible to wind damage, and will not grow on poorly drained soils.

The fruit is yellow in colour, becoming red or brown. The flesh is yellow - white and more solid and granular than some of the other annonaceous fruits. Otherwise similar to the cherimoya.

Nutritional composition of the custard apple per 100 grams of edible portion is: Water - 71.5%, Energy - 101 calories, Carbohydrate - 25.2 g, Fat - 0.6 g, Protein - 1.7 g, Ash - 1.0 g, Calcium - 27 mg, Iron - 0.8 mg, Phosphorous - 20 mg, Vitamin A - trace, Thiamin - 0.08 mg, Riboflavin - 0.10 mg, Niacin - 0.5 mg, Ascorbic acid - 22 mgs.

Annona squamosa (sugar apple, sweetsop)

Often believed to be the true custard apple, the sugar apple is a slow growing, bushy, deciduous tree of about 5 m. It is drought tolerant.

The fruit is yellow - green in colour with a pale yellow, firm flesh which is sweet and custard like. Fruiting occurs from 3 years with seedling trees and as early as 1 year old with grafted trees. A very productive species.

Nutritional composition of the sugar apple per 100 grams of edible portion is: Water - 73.3%, Energy - 94 calories, Carbohydrate - 23.7 g, Fat - 0.3 g, Protein -1.8 g, Ash - 0.9 g, Calcium - 22 mg, Potassium - 275 mg, Sodium - 11 mg, Iron - 0.6 mg, Phosphorous - 41 mg, Vitamin A - 10 I.U., Thiamin - 0.10 mg, Riboflavin - 0.14 mg, Niacin - 1.0 mg, Ascorbic acid - 34 mgs.

Annona muricata (soursop)

A small, upright tree reaching about 5 m in height which is otherwise known as prickly custard apple. It is drought tolerant and makes a good windbreak or shade tree. It is less frost tolerant than the other species (0°C).

The fruit is the largest of the custard apples and more acid, so is often best stewed with a little sugar. The texture can be somewhat slimy, but the juice is abundant and sweet and makes good drinks.

Nutritional composition of the soursop per 100 grams of edible portion is: Water - 81.7%, Energy - 65 calories, Carbohydrate - 16.3 g, Fat - 0.3 g, Protein - 1.0 g, Ash - 0.7g, Calcium - 14 mg, Potassium - 265 mg, Sodium - 14 mg, Iron - 0.6 mg, Phosphorous - 27 mg, Vitamin A - 10 I.U., Thiamin - 0.07 mg, Riboflavin - 0.05 mg, Niacin - 0.9 mg, Ascorbic acid - 20 mgs.

Fruiting begins at about 4 years with seedling trees, 3 years with grafted trees. The seeds are said to have insecticidal properties.

PAWPAW *(Asimina triloba)*

Family: ANNONACEAE

Although called pawpaw in Australia, this species is not a true pawpaw, but is related to the custard apples. Other common names include custard banana and Michigan banana. There are other *Asimina spp* but none show the promise of this one.

A deciduous shrub or low tree, native to north America and growing, under favourable conditions, up to 12 m. It occurs naturally as a thicket understorey in open woodland. In dryer areas it tends to hug the watercourses. The straight trunk rarely exceeds 30 cm in diameter but some have been measured to 150 cm. A single tree can sucker out to about a quarter of an acre in ideal conditions, if allowed. It is able to cope with snow conditions.

Wood ash is said to be a good fertiliser for the tree but better results were observed from using old plaster from a building. The tree has brittle branches and is very prone to wind damage. It prefers well drained, fertile soil, rich in organic matter. Severe spring frosts can destroy flowers resulting in crop loss. It is tolerant of fairly saline water.

The fruit is the largest native fruit of North America (weighing up to 300 grams) and develops in autumn. When fully ripe the fruit skin is dark brown or almost black. The soft creamy fruits are said to have the flavour of banana custard and are delicious eaten raw. They can be dried and are also used for making preserves, pies, puddings and desserts. The yellow fruiting varieties are said to be superior to the white. Nutritionally, the fruit comprises carbohydrate - 16.8% (of this, 16% is sucrose, 35% reducing sugars and 52% reducing sugars after inversion), protein - 5.2%, fat - 0.9%, ash - 0.5%, water - 76.6%. Handling the fruit can cause skin rashes on some people. Pigs and poultry are reported to not eat the fruit.

The wood is light (specific gravity of 0.3969), spongy, coarse grained, weak and of little value, although it had been used in local construction in the pioneer years. The inner bark was stripped from the branches in the early spring and made into a string which was used to manufacture fishing nets, fishing lines and rope.

The seeds contain a colourless and tasteless alkaloid called asimine, which acts on the brain of animals causing somnolence then stupor and finally unconsciousness. It also has emetic properties. The bark contains the alkaloid analobine and was once used in medicine.

The plant can be grown from seed which needs stratification. Given the wide natural occurrence of the plant in the wild, it would probably pay to try to match seed source conditions to local environment. Germination seems to occur best in very warm conditions. The seedlings are usually planted out while dormant, when they reach 300 mm, although some advocate direct sowing the seed. There may be a root associate which promotes fast and healthy growth, but as yet this has not been isolated. Cultivars exist and the plant is readily grafted and also grows from root cuttings and layering. Fruiting seems to benefit from cross - pollination.

GUAVAS *(Psidium spp)*

Family: MYRTACEAE

Psidium guajava (guava)

A small, branching, evergreen, Mexican native tree, attaining a height of 2 - 10 m. It branches close to the ground, and often produces suckers at the base of the trunk. The guava is susceptible to frost, (tolerant to - 2°C), but if not too severe, it will recover by suckering from below the soil. It does best in high rainfall areas, but will tolerate 4 - 5 months of drought. It is also reported to be tolerant of flooding and somewhat salt tolerant. It will grow on a variety of soils, although does not like heavy clay soils. It seems able to withstand some waterlogging. In cooler climates, guavas can be grown in a hot house, and are well suited to container growing.

The fruit are highly scented, yellow in colour when ripe and globose in shape. They are produced over a long period. The pulpy flesh is sweet - acid, and contains many hard, kidney - shaped seeds. It has 2 - 5 times the Vitamin C content of fresh orange juice and is also a good source of Vitamin A. The fruits are best eaten fresh, but can also be made into jams, jelly, paste, juice and nectar. Seedling trees will begin bearing fruit at about 2 years of age.

Nutritional composition of guava per 100 grams of edible portion is: Water - 83%, Energy - 62 calories, Carbohydrate - 15 g, Fat - 0.6 g, Protein - 0.8 g, Ash - 0.6 g, Calcium - 23 mg, Potassium - 289 mg, Sodium - 4 mg, Magnesium - 13 mg, Iron - 0.9 mg, Phosphorous - 42 mg, Chlorine - 155 mg, Sulphur - 105 mg, Silicon - 30 mg, Vitamin A - 280.U., Thiamin - 0.05 mg, Riboflavin - 0.05 mg, Niacin - 1.2 mg, Ascorbic acid - 242 mgs and the digestion time is 3 hours.

In some countries, the tannin - rich leaves and bark are used for dyeing and tanning. Guava wood is very heavy and strong and can be used for tool handles and implements. It has a fine reddish to yellow grain and is used in carpentry and joinery. It also makes excellent firewood and charcoal.

Because of their astringency, the roots, bark, leaves and immature fruits are commonly used for gastroenteritis, diarrhoea and dysentry throughout the tropics. Crushed leaves are applied to wounds, ulcers and rheumatism and the leaves are chewed to relieve toothache. The leaf concoction can be taken as a remedy for coughs, throat and chest ailments, gargled to relieve mouth ulcers and inflamed gums. It can also be taken as a vermifuge and to promote menstrual flow.

Trees are propagated from seed, cuttings and suckers. When grown from seed, about 70% will grow true to type. Because of the variability of guava fruits, vegetative propagation from superior plants is more common. Minimum spacing between plants is 3 m.

Psidium cattleianum (strawberry guava)

A compact, evergreen shrub, growing to a height of 3 - 6 m. It is believed to be native to the Brazilian lowlands. The fruit are small (about 2 cm diameter) and round, deep wine - red in colour (also a yellow variety available) with a thin skin. The flesh is juicy and has a texture and flavour similar to a strawberry. The yellow variety is larger fruited (about 3 cm diameter) and a creamier and nicer flavour.

Nutritional composition of the strawberry guava per 100 grams of edible portion is: Water - 81.8%, Energy - 65 calories, Carbohydrate - 15.8 g, Fat - 0.6 g, Protein - 1.0 g, Ash - 0.8 g, Calcium - 23 mg, Potassium - 289 mg, Sodium - 4 mg, Iron - 0.9 mg, Phosphorous - 42 mg, Chlorine - 155 mg, Sulphur - 105 mg, Silicon - 30 mg, Vitamin A - 90.U., Thiamin - 0.03 mg, Riboflavin - 0.03 mg, Niacin - 0.6 mg, Ascorbic acid - 37 mgs and the digestion time is 3 hours.

The strawberry guava is hardier to frost than *P. guajava* (to - 5°C), but is less tolerant of drought and flooding. *P. littorale* is a very closely related species, but has a different shaped fruit and leaves which are narrower towards the base.

Psidium guineense (Brazilian guava)

This slow growing, evergreen shrub to small tree (1 - 7 m) has the widest natural distribution of all the guavas. It occurs from southern Mexico through Central America, Peru and northern Argentina.

The fruit is greenish yellow and apparently lacks the musky aroma of the common guava. It is eaten fresh and is said to make the best jelly of all the guavas.

The bark is rich in tannin and used for tanning. The wood is strong and used for tool handles, beams and planking. A bark or root concoction is used to treat urinary diseases, diarrhoea and dysentry, varicose veins and ulcers on the legs. A leaf decoction is taken for colds and bronchitis.

FEIJOA *(Feijoa sellowiana)*

Family: MYRTACEAE

Another common name is pineapple guava.

A bushy, evergreen shrub (1 -6 m) which is native to southern Brazil, northern Argentina, western Paraguay and Uruguay. It is cultivated in the highlands of Chile, New Zealand and Australia.

It prefers a deep, rich, organic soil which is kept summer moist. It is drought tolerant but does not produce much fruit under drought stress. It prefers a cool season and produces a better flavoured fruit in cooler regions. It can tolerate temperatures down to - 11°C. The plant has a shallow fibrous root system.

The fruit is variable depending on the tree and the season. It has the flavour suggested by the common name pineapple guava. It is delicious eaten out of hand but is also a valuable addition to fruit salads. The fruit is high in pectin and makes a good jelly.

Nutritional composition of the feijoa per 100 grams of edible portion is: Water - 84%, Fat - 0.2 g, Protein - 0.9 g, Ash - 0.5 g, Calcium - 4 mg, Potassium - 166 mg, Sodium - 5 mg, Magnesium - 8 mg, Iron - 0.05 mg, Phosphorous - 10 mg, Iodine - 0.165 - 0.39 mg, Ascorbic acid - 28 - 35 mgs and the digestion time is 3 hours.

It is a good windbreak species. Propagation is by seed (plants grow reasonably similar to the parent), cuttings and by graft.

UGNI *(Ugni molinaea*, **syn.** *Myrtus ugni, Ugni molinae)*

Family: MYRTACEAE

Other common names Chilean guava and myrtle berry

A slow growing, evergreen shrub (to 2 m) native to Chile. The plant is drought tolerant and can withstand some frost. In the wild it is found in mountainous forest clearings, but is also grown as an ornamental and fruiting hedge in cultivation.

The branches sometimes hang down to the ground where they readily take root. This is one means of propagation along with cuttings and seed.

LILLIPILLIS *(Eugenia spp, Acmena spp, Syzigium spp)*

Family: MYRTACEAE

***Eugenia smithii, syn. Acmena smithii* (lillipilli)**

The most widely distributed and probably the best known of the Australian Eugenias. Native to Queensland, NSW and Victoria, this medium sized to tall tree (up to 30 m) may only ever attain shrub height in exposed coastal positions.

It grows on a wide range of soil types, although seems to grow best on the banks of rivers and streams.

The purplish or white fruit is edible although does not have an outstanding flavour. It bears large quantities of fruit over a long period of autumn and winter and probably has potential as a pig and poultry food. An early Australian botanist observed that the fruit was favoured by parrots, Aboriginals and small children. It is a good addition to any fruit forest, especially those designed for schools and children.

The wood is light coloured, moderately strong, close grained, durable in weather but not in the ground or in situations where it does not drain. The timber can be used in general building work and when seasoned it can be used in internal fittings and frames.

Natural companions include *Acacia melanoxylon* and *Cissus hypoglauca* (native grape). Propagation is from seed.

Eugenia uniflora (Brazil cherry, Surinam cherry, pitanga)

This native South American evergreen shrub to small tree (up to 3.5 m) is a useful fruiting hedge species. It is tolerant of drought, shade, wind, salt spray and frosts to - 2°C.

It usually takes about twenty years to reach full height but often bears fruit in its third or fourth year. The fruit ripens a few weeks after flowering. It often bears two crops a year in warmer climates.

Nutritional composition of the pitanga per 100 grams of edible portion is: Water - 85.8%, Energy - 51 calories, Carbohydrate - 12.5 g, Fat - 0.4 g, Protein - 0.8 g, Ash - 0.5 g, Calcium - 9 mg, Iron - 0.2 mg, Phosphorous - 11 mg, Vitamin A - 1500 I.U., Thiamin - 0.03 mg, Riboflavin - 0.04 mg, Niacin - 0.3 mg, Ascorbic acid - 30 mgs.

In Brazil the leaves are spread on the floor and release an aroma when walked on which repels flies. The bark is rich in tannin and is used for tanning leather. The seeds are toxic.

It can be propagated from seed and cuttings.

Eugenia dombeyi, syn. Eeugenia brasiliensis (grumichama)

An evergreen, slender, erect, short trunked, heavily foliaged tree (to 10.5 m) native to coastal southern Brazil. It can withstand temperatures as low as - 3°C.

It grows best on deep, fertile, sandy loam. The plant is very slow growing. Fruiting begins when the plant is 4 - 5 years old. The fruit is deep crimson to almost black, 1.25-2 cm wide, with soft melting flesh and is eaten out of hand or made into jams and jellies.

Nutritional composition of the grumichama per 100 grams of edible portion is: Water - 83.5%, Protein - 0.102 g, Ash - 0.43 g, Calcium - 39,5 mg, Iron - 0.45 mg, Phosphorous - 13.6 mg, Carotene - 0.039 mg, Thiamin - 0.044 mg, Riboflavin - 0.031 mg, Niacin - 0..336 mg, Ascorbic acid - 18.8 mgs.

Germination is by seed which has very short viability (a few weeks).

Syzygium jambos (rose apple)

An attractive, evergreen tree native to the East Indies and Malaysia. It grows to 13 m with a spread of 4 m. It is frost and drought tender, preferring an open, sunny position on deep, well drained, fertile, humus rich soil, although it is known to flourish on sand and limestone with little organic material.
The pale yellow, crisp, sweet fruits are eaten fresh, stewed, made into jams and jellies and fermented into a wine. They have a distinctive rose flavour. The fruit can be distilled 4 times to make first grade rose water.

Nutritional composition of the rose apple per 100 grams of edible portion is: Water - 84.5 - 89.1%, Protein - 0.5 - 0.7 g, Ash - 0.43 g, Fat - 0.2 - 0.3 g, Carbohydrates 14.2g, Fiber - 1.1 - 1.9 mg, Magnesium - 4 mg, Calcium - 29 - 45.2 mg, Iron - 0.45 - 1.2 mg, Phosphorous - 11.7-30 mg, Sodium - 34.1 mg, Potassium - 50 mg, Copper - 0.01 mg, Sulphur - 13 mg, Chlorine - 4 mg, Carotene - 123 - 235 I.U., Thiamin - 0.01 - 0.09 mg, Riboflavin - 0.028 - 0.05 mg, Niacin - 0.521 - 0.8 mg, Ascorbic acid - 3 - 37 mg.

The branches are used for making baskets. The bark has been used for tanning and contains a brown dye. The roots and seeds are said to be poisonous.

Propagation is from seed (which is polyembryonic), air - layering or tip cuttings.

Syzygium cumini (Java plum, jambolan, black plum)

A fast growing, evergreen native of Indonesia and northern Queensland, which grows from 5 - 30 m with an open, spreading crown, often exceeding the height. It is frost tender and drought tolerant when established, preferring a protected, partially shaded position on deep, well drained, fertile, humus rich soil. It thrives along watercourses. It needs a near tropical climate to produce fruit.
The purple - black, olive shaped, somewhat astringent fruits are eaten raw and in jams, jellies, preserves, liquors, vinegar and pies. A wine resembling port in taste and colour is made from the fruit. The fruit is sometimes soaked in salt water to remove the astringency. The bark is used in the preparation of a sugar cane juice wine.

Nutritional composition of the Java plum per 100 grams of edible portion is: Water - 83.75 - 85.8%, Protein - 0.7 - 0.129 g, Ash - 0..32 - 0.4 g, Fat - 0.15 - 0.3 g, Carbohydrates 14.0 g, Fiber - 0.3 - 0.9 mg, Magnesium - 35 mg, Calcium - 8.3 - 15 mg, Iron - 1.2 - 1.62 mg, Phosphorous - 15 - 16.2 mg, Sodium - 26.2 mg, Copper - 0.23 mg, Potassium - 55 mg, Sulphur - 13 mg, Chlorine - 8 mg, Carotene - 80 I.U., Thiamin - 0.008 - 0.03 mg, Riboflavin - 0.009 - 0.01 mg, Niacin - 0.2 - 0.29 mg, Ascorbic acid - 5.7 - 18 mg.

The wood is red, greyish - red or greyish - brown, coarse and hard, with a close, straight grain. Although difficult to work, the kiln dried wood achieves a high polish. It is durable in water and resistant to borers and termites. In India and Pakistan it is used extensively for posts, beams, cart shafts, solid cart wheels, yokes, boat building, hut construction, oars, canoes, boat masts, house building, rice mortars, turnery, furniture and is an acceptable fuel. The bark contains 13 - 19% tannin and is used in tanning and preserving fishing nets. The bark yields a durable brown dye.

The flowers produce an abundance of nectar, which produces a fine honey but this ferments in a few months. The tree is a host to the tsar silkworm. The seed is fed to cattle and is rich in protein and carbohydrates.

The leaves are astringent, their juice is used to treat dysentry with blood discharges and is given in 2 - 4 fluid ounce doses. The bark is astringent also and its juice is given in similar doses for chronic diarrhoea and dysentry and for menorrhogia. A decoction of the bark is used as a mouth wash and gargle for treating spongy gums, stomatitis, relaxed throat and other mouth diseases. A paste of the burnt bark is mixed with a bland oil and is used to treat burns and scalds. The fruit juice is astringent, stomachic, carminative, antiscorbutic and diuretic and is used in enlargement of the spleen, chronic diarrhoea and suppressed or scanty urine. The seed is astringent and efficacious for diabetes, mellitus and glycosuria. It quickly reduces sugar in urine. The leaves, stems, flowerbuds, opened flowers and bark are found to have an antibiotic effect.

Propagation is from seed or tip cuttings.

Syzygium bungadinnia (paperbark satlnash)

The fruit is a staple, seasonal food of the Cape York Aborigines.

Syzygium coolminianum (blue lillipilli)

Native of Queensland and New South Wales, this is a small to medium, (to 10 m with a spread of 3 m), evergreen tree. It is drought and frost tender and prefers medium to light, well drained, rich soils.

The 2.5 cm fruit is rich, purple to blue and said to be among the. best in flavour of the Australian liliipillis. It is eaten raw and made into jellies.

Syzygium cormiflorum (purple cherry)

A native of New South Wales and Queensland. The fruit is borne on old wood rather than young growth.

Syzygium crebrinerve

A native of the forests of New South Wales and Queensland growing to 20 m and spreading to 5 m. It is frost and drought tender and prefers a medium to light, well drained soil in an open sunny position.

The reddish purple fruit is 2 cm across and edible.

Syzygium forte (white apple)

Said to be a tasty fruit.

Syzygium hodgkiosoniae (smooth barked rose apple)

Native of eastern Australia, now threatened with extinction due to overclearing. Produces a large fruit.

***Syzygium luehmannii* (cherry alder, small leaved lillipilli)**

This evergreen tree grows to 30 m and spreads to 6 m and is native to Queensland and New South Wales. It is drought resistant and frost tender, preferring medium to light, well drained but moist soils in an open sunny position.

The edible, aromatic, pear shaped, pink to red fruit are often borne in great quantities and are eaten fresh, and in jams and jellies.

Syzygium minutiflorum

Said to bear a tasty fruit.

***Syzygium moorei* (robby, durobby)**

An evergreen native of New South Wales which grows to 25 m and spreads to 4 m. It is frost resistant and drought tolerant and prefers a heavy to medium, moist soil in a protected and partly shaded position. Now threatened with extinction due to overclearing.

The old wood bears a red flower followed by a large, rounded, white to cream coloured, tinged with green, fruit. The succulent fruit can be as large as 6.5 cm and is eaten fresh and made into jams and jellies.

***Syzygium oleosum* (blue lillipilli)**

Native to Queensland and New South Wales, this small to medium sized tree can be found growing along the edges of rainforest and in seaside scrubs. The fruit is said to be the best flavoured of the lillipillis and is eaten fresh and used in making jams.

***Syzygium panicuiatum* (creek satinash, magenta lillipilli)**

A small shrubby tree (growing to 20 m and spreading to 4 m) of coastal rainforests of New South Wales. It is drought tolerant but frost sensitive, preferring a heavy to medium, moist soil in a protected and slightly shaded position. The juicy, purple fruits are eaten out of hand and made into jellies.

Propagation is by seed or cuttings.

BLUEBERRIES *(Vaccinium spp)*

Family: ERICACEAE

Growing as a small bush to small tree (0.3 - 6 m), depending on the species and variety, the blueberry is deciduous and native to North America. It requires a well drained and very acid soil with plenty of humus for optimum growth. It may be propagated from seed or from cuttings.

FUCHSIA *(Fuchsia spp)*

Family: ONAGRACEAE

There are over 100 species of fuchsia native to South America and New Zealand. They range from small shrubs to small trees (up to 6 m). They are easily grown in tubs. Some species prefer full sun although the more frost tolerant ones prefer partial to full shade. The native New Zealand konini *(F. exorticata)* and the South American *F. magellanica* are particularly frost hardy. They prefer a well drained, moist garden soil.

The fruit may be eaten raw or in jellies and is best when eaten one or two days after the flower has dropped from the fruit. The darker varieties of fruit seem to be better tasting. The flower is also edible.

HACKBERRY *(Celtia Australia)*

Family: CELTIDACEAE

Also known as the nettle tree, the hackberry belongs to the same family as the elm. It is a small to medium sized tree native to southern Europe, N. Africa and Asia Minor. It grows to a height of 25 m, is round headed, is a useful shade tree and is reasonably frost hardy. The fruits are the size and colour of an edible green pea, and are sometimes eaten in countries where food is scarce. In cooler climates, the serrated leaves change to a pale yellow in autumn. The fruits becomes purple - black when ripe, although sometimes orange - red. They have a sweet flavour and can be eaten raw or used for jams, jellies or wines. They are a good addition to a chicken forage system.

IRISH STRAWBERRY TREE *(Arbutus unedo)*

Family: ERICACEAE

This attractive and easily grown evergreen tree is a native of the Mediterranean region, Asia minor and Ireland. It is a small, rounded, densely foliaged tree or large shrub, growing to a maximum height of 7 m with a width of 6 m, but rarely exceeding 5 m. It is a good shade tree, preferring a moist soil. It is frost tolerant as well as being moderately tolerant of drought, shading and salt spray.

It is tolerant of most soil conditions, but alkaline or waterlogged soils should be avoided. It can tolerate some salt winds, and most climates, but with the exception of tropical climates. In New Zealand it volunteers itself as an understorey to *Pinus radiate.*

The fruits, like round berries, ripen during autumn and winter and are edible when red. The fruit can take up to 12 months to ripen, therefore trees often have flowers, as well as green, white, yellow and red fruits at the same time. They can be eaten raw, preserved, made into syrup, wine, brandy, liqueurs, or made into a cider - like drink. The Irish strawberry also has some value as part of a bee forage system. The bark leaves and fruit are used for tanning. The plant can be planted densely and kept as a hedge.

Trees are grown from seed, and for best results a pollinator is desirable.

JAPANESE RAISIN TREE *(Hovenia dulcis)*

Family: RHAMNACEAE

A deciduous tree native to Japan, China and the Himalayas, it is suited to temperate and subtropical climates, and is very hardy to cold. The tree can grow to 18 m.

The swollen stem which holds the inedible fruit is the part that is eaten and, as the name implies, tastes somewhat like raisins. In China they are used to annul the effects of wine. The seeds, boughs and young leaves were used in preparing a honey substitute. It is a good spring honey plant.

OTHER UTILITY PLANTS

CAROB *(Ceratonia siliqua)*

Family: CAESALPINIACEAE

The carob is said to be the largest (to 15 m) of Europe's leguminous trees, and is a native to the Mediterranean region. It grows in minimum rainfall areas of 250 mm, but does better with higher rainfalls. It is sensitive to cold below - 4°C when young, but mature trees suffer little damage at - 8°C. These evergreen trees can spread their crowns out to 10 m and prefer slightly alkaline, sandy soils with good drainage, but will grow in virtually any soil including rocky ground, but with the exception of compacted clay. Their life span is 500 or more years.

They are generally dioecious, requiring male and female trees to set pods but are occasionally hermaphrodite. The pod is a fleshy bean up to 300 mm in length and is both flavoursome and nutritious. The ranges of reported nutritional analysis are: Crude protein 2.25 - 21.0%; Crude fat 0.5 - 1.5%; Crude fibre 4.65 - 13.3%; Nitrogen free extract 74.1 - 75.97%; Ash 1.52 - 2.8%; Calcium 0.13 - 0.28%; Total sugars 37.1 - 56.6%. The pods are excellent stockfeed, commercially sold as chocolate substitute human food, and the seed contains gums with industrial uses. The bean also has potential to produce alcohol fuel.

Yields of 1 tonne of pods from a single tree have been reported from some trees in a good season, but about 10% of that is more likely and would still yield in the order of 8 t/ha. Western Australia is fortunate to have gained budwood from a carob variety collection in California that was destroyed by urban sprawl. This collection was brought to W. A. by Henry Esbenshade, and will be used as a source of scion wood for nurseries and land holders.

Australia spends about $60,000 annually on imported carob powder and demand has been increasing at about 20%/yr. Machinery to powder carob pods is not a complicated arrangement and could be shared amongst a group of farmers. If farmers took the trouble to powder their pods, they could expect a year 10 return of $6,765/ha with full irrigation, $3,025 with minimum irrigation and $ 1100 with no irrigation, at a planting density of 90 - 100 trees/ha. (1985 prices)

Some degree of salt tolerance has been observed in carobs growing along waterways and in low lying areas in both Australia and Israel. The carob tree is reported to not burn easily, and when scorched by fire, it generally recovers. Stock will also trim the foliage to within their reach, but no work appears to have been done on the nutritional values of the foliage.

They have been grown in Algeria as companions to grapes with good results. They grow well with tagasaste, *Albizia lophantha* and *Acacia decurrens* as nurse plants.

Tap roots of mature trees have been traced down to 20 m. A carob seedling develops a long tap root at a very early age: about 250 mm in the first two weeks (from germination). Trees that remain in shallow pots do not develop ideal root systems and lose the advantage of drought tolerance.

Direct seeding of carobs is possible and is best done using protective markers such as old tyres. However during germination, moisture must be maintained, so it is often desirable to start the seedlings in deep pots and move them out after a couple of weeks. One litre milk cartons with a few drainage holes punched in the side near the base make ideal starter pots.

Carobs can be sown at any time of the year, although young seedlings are frost susceptible. Seedlings may be protected in the field using clear fertiliser bags and stakes as improvised mini - hothouses. Establishing the trees over summer eliminates the frost problem, but watering is necessary. It is often convenient to arrange planting so as not to conflict with other seasonal activities. For example, establishing the trees in the wheatbelt before the rain "breaks", means that the farmer is free to attend his crop after the first rains, and the carobs will require no special treatment.

Carob seeds have very hard protective cases and need to be scarified (cracked). The easiest method is to pour boiling water over the seeds and allow them to soak overnight. Repeat the procedure on any seeds that have not swollen. The seed can then be sown into pots.

Planting out: when transplanting the seedling, it must be removed from the milk carton. Using a sharp knife, cut the base from the milk carton and run a cut up one side of the carton, being careful not to penetrate into the root system. Gently place the seedling, still in its carton, into a prepared hole so that it sits on firmed - down soil and so as to place the seedling at ground level. Lightly fill around the pot, then slide the carton vertically up whilst holding the seedling in place.

Water well and press the soil firmly around the seedling, leaving a slight depression around it so water can collect when rain falls.

Closer planting of seedlings, allows for natural deaths and final selection of better fruiting females and well placed males. This selection can be made after the first couple of seasons of fruiting (7-8 years), or alternatively, known cultivars can be grafted onto the rootstock to produce a certain crop at an earlier stage.

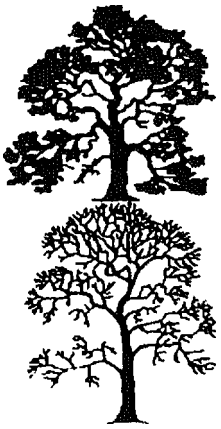
OAKS (Quercus spp)

Family: FAGACEAE

There are about 600 species of oaks, native to Europe, Asia and North America. Some are evergreen, but most are deciduous, usually large, long lived trees (500 - 700 years), but occasionally shrubs, and extending from cold temperate to tropical regions.

They all have seeds in the form of acorns but vary widely in size, shape and palatability to stock and humans. Acorns of the white oak group generally contain less tannin than the black oaks and are therefore more palatable. Acorns for propagation should never dry out.

Generally, oaks have low combustibility and can be incorporated into system designs as fire barriers.



***Quercus agrifolia* (Californian live oak, coast live oak)**

A small, slow growing, evergreen tree which is a low growing shrub in dry climates (6 - 15 m). It is a native of California and Mexico, where the acorns were eaten by the Indians. The astringency is leached out with water and the acorns ground into a meal for use in breads, soups and stews.

***Quercus alba* (white oak)**

A tall (to 30 m), small - crowned tree in forest conditions and common in North America, where the acorns were leached, boiled and eaten like chestnuts. The bark was also used as a medicine. The timber is prized for barrels as it does not taint liquids.

***Quercus bicolor* (swamp white oak)**

A native of south eastern Canada and eastern USA, this tall tree (to 30 m, 4 m spread) is at home in wetlands. The acorns are edible after leaching. They were roasted, ground into a meal and mixed with other foods or moulded into loaves and cakes.

***Quercus cerris* (Turkey oak)**

A handsome, wide, spreading deciduous tree to 36 m, with a girth of 4 - 5 m, and said to be the fastest growing of all oaks. It likes hot climates and tolerates drought. A native to south eastern Europe through to western Asia. Excellent in chalk soils and in areas of maritime exposure.

Acorns are ground and made into bread. The branches yield a manna like substance called gaze, which is boiled down to a syrup and mixed with flour to form a sweetmeat. The wood is rosy with a slight lavender tinge and is heavy and hard, but prone to splitting.

***Quercus emoryi* (blackjack oak)**

A native to the south west USA, this tree usually grows to 6 m but sometimes to 15 m.

***Quercus frainetto* (Hungarian oak)**

A deciduous tree to 30 - 40 m, it is remarkably fast growing on light, fertile soil.

***Quercus ilex* (holm oak, holly oak)**

An erect and symmetrical evergreen tree from the Mediterranean region, where it often grows as a companion to *Quercus suber*, In adverse conditions it remains a shrub, but can attain heights of up to 25 m and can grow as wide as it is high with a broad, oval dense crown. It has a short trunk which may reach or exceed 3 m in girth. It is very tolerant of drought once established and is tolerant of heat, and cold (to about - 12°C). It will grow well even in limestone subsoils and will propagate from acorns or from root suckers.

The acorns are a favourite food of pigs, giving their meat a special flavour. It is considered the best European acorn for human consumption and also the source of an edible oil. Like many of the oaks, it is an alternate bearer, each tree bearing a heavy crop one year, then a lesser load the following year. By planting a grove of these trees the annual yield is fairly constant. One Portuguese tree yielded 1200 litres of acorns in a good season. Every other year it only produced about 240 litres.

Quercus lobata (Californian live oak, valley oak)

The largest of the western hardwoods, spreading 10 m and growing up to 36 m tall. A good crop can be expected every third year (one tree was recorded as having yielded a tonne in a single year). The acorns were used for flour, by the Indians, after roasting. Some acorns are almost tannin free. The timber is considered fair to poor.

Comparison of Food Values of *Q. lobata* Acorns with Rival Foods

(Expressed as %):Based on Smith

	Cornmeal	*Wheat four*	*Q. lobata Leached*	*Q. lobata Unleached*
Water	12.5	11.5	11.34	8.7
Ash	1.0	0.5	0.29	2.0
Fat	1.9	1.0	19.81	18,6
Protein	9.2	11.4	4.48	5.7
Carbohydrate	74.4	75.4	62.02	65.0
Fibre	1.0	0.2	2.06	
Tannin	-	-	-	6.63

Quercus macrocarpa (burr oak)

A large, widely distributed North American tree. Reaching up to 52 m, it has a straight trunk up to 2 m in diameter.

The acorns are considered to be among the most palatable of all. Gelatine can be used in the leaching process to remove tannin without removing sugar.

Quercus michauxil, syn. Quercus prinus (swamp chestnut oak, basket oak)

A large tree, growing to 40 m high and spreading to 30 m, on rocky banks and hillsides. A native of the south east USA, where it tolerates wetland conditions. The acorns are bitter and very large and are eaten in cooking after leaching. A good quality timber tree.

Quercus muehlenbergii (chinquapin oak)

Also called the yellow chestnut oak, this deciduous native of central eastern USA, produces a sweeter acorn than most oaks. It is fast growing, to 27 m, with a spread of up to 19 m.

Quercus petraea (durmast oak, sessile oak)

A deciduous tree to 30 - 40 m, with a thick trunk and a broad dense crown. It is damaged by late frosts, will not tolerate wet soils but likes stony places with good drainage. It produces a good furniture timber and is also used for flooring, roofing timbers and shipbuilding.

Quercus phellos (willow oak)

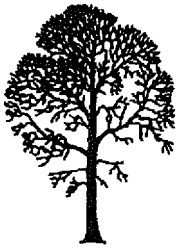
A large deciduous oak, (to 38 m high and spreading to 38 m), of east and central USA. The timber is not highly regarded.

Quercus robur (English oak)

A native to most of Europe, excluding the extreme north, but including parts of the Mediterranean region, this tall (to 50 m), majestic tree has a stout trunk and large irregular crown. It prefers light and fertile alkaline soils and withstands frost.

The acorn was used as a famine food for humans in Europe, but it is high in tannin. The acorns are also used as a coffee substitute and the manna is used as a kind of butter in cooking.

The wood is easy to work, highly attractive and long lasting. It has been used traditionally for making casks for ageing valuable wines and brandy. It is also used for furniture, shipbuilding and roofing timbers.



***Quercus rubra, syn. Quercus borealis* (red oak)**

A broad, deciduous tree with spreading branches and a rounded crown growing to 27 m. It is native to eastern USA. The acorns are bitter but edible after leaching. It is said to neutralise an acid soil.

***Quercus suber* (cork oak)**

A native of the central western Mediterranean region and the Atlantic coast of Africa, this fairly slow growing evergreen attains heights of up to 20 m and is often as wide. The growth rate and size attained depends largely on soil depth and moisture. It prefers a deep soil but needs good drainage. It requires a sunny position and thrives in poor, acid and sandy soils and is drought tolerant. It is hardy to about - 15°C and tolerates extreme heat. It is best planted where it is to grow as it forms a long tap root (as much as a metre, before showing any signs above the ground of having germinated). This is necessary, if the tree is to be drought resistant. Acorns should never dry out before planting into damp soil. It may be necessary to keep acorns in damp peat under refrigeration until the soil is damp.

The acorn was used as a source of drought food for humans and is highly acclaimed as a stock feed. Acorns are usually roasted for human consumption. One tree in Portugal had a spread of 13 m and yielded some 840 litres of acorns in a single season, enough to feed a pig for 120 days and raise its live weight by 59 kg.

Commercial cork (the outer bark of Q, *suber)* is harvested in sheets, after about year 20, on a 10 year cycle, for hundreds of years. The average crop of cork in Portugal is around 240 kg/ha/yr (there is the annual pork harvest as well). The highest quality cork is said to come from the dry, rocky soils. The timber qualities of this tree are not highly regarded although the wood does produce a high grade charcoal.

***Quercus virgfniana* (southern live oak, live oak)**

A relatively fast growing, massive, evergreen tree attaining heights of 15 - 20 m. It tolerates most soils but may only reach full size in deep, moist, enriched soils (it occurs naturally on both well drained and poorly drained sand). It will lose its leaves at about - 10°C and is hardy to about - 20oC. It is tolerant of heat if it has water. On dry sites it remains a dwarf. It is easily transplanted and is said to aid the growth of citrus.

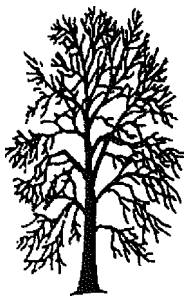
The acorns were used by the Indians for thickening stews. They yield an oil which is said to be comparable to olive oil. Acorns can be roasted and made into coffee substitute.

BEECHES *(Fagus spp)*

Family: FAGACEAE

There are about a dozen species of the genus *Fagus,* all originating from northern temperate regions. They are deciduous trees, shallow rooted and yielding a dense, even - grained timber. Although hardy, they do not grow well in heavy or wet clay soil, or in situations where they are exposed to heavy prevailing winds or salt spray. They are tolerant of alkaline soils.

The beech is propagated either by seed or by rooted suckers which are put out freely. It can also be grafted.



***Fagus sylvatica* (common beech, European beech)**

An impressive tree growing to over 40 m tall, with a spreading crown capable of forming an area of dense shade 35 m in diameter. The spectacular autumn foliage is golden in colour and there are also a number of purple and coppery leaved forms *(F sylvatica van airopuinicea).* It prefers light, well drained soils and grows well on chalk soils and limestone soils, where it is often the climax species.

It can provide long clean trunks of timber, straight - grained and free from knots. The wood is rosy coloured, hard, strong and easily worked, and is much in demand for furniture, especially chairs, flooring, handles and turnery, veneers, plywood and modern demified board. It is however fairly brittle and so is not well - suited for purposes where strength and durability are required. It also makes excellent firewood.

In England, the common beech is often used as a hedge. The fruit or beechmast is a very good animal feed, and has long been a traditional food for pigs and fattening poultry in Europe. In England, park deer feed on beechmast. It is potentially a good food for humans and was eaten by the N. American Indians. The early settlers used roasted beech nuts as a coffee substitute and the inner bark of the beech tree has been used to make bread. Well ripened beechmast yields 17 - 20% of a non - drying oil similar to hazel and cottonseed oils, which can be used for lighting, cooking, or as a salad - oil or butter substitute and the residue used as animal feed. The nutritional composition of the beechnut is; protein 21.8%, fat 49.9%, carbohydrates 18%, ash 3.7%, water 6.6%.

The annual yield of beechnuts tends to be variable. The foliage forms a good animal forage and the very young leaves are good in salads. The wood ash is high in potash. For medicinal uses, the tar is stimulating and antiseptic and can be used as an expectorant in chronic bronchitis or externally as a treatment for various skin diseases.

WILLOWS *(Salix spp)*

Family: SALICACEAE

Willows generally use large amounts of water, will grow in waterlogged soil and have root systems that have been known to reach out as far as 50 m laterally in search of moisture and nutrient. For this reason, they are extremely good trees for sheet, gully and slump erosion and for salinity control, but should not be planted close to gardens, septic systems and orchards. Willows will generally tolerate prolonged periods of flooding. They are fast growing, yield a soft, light timber, and provide useful fodder for stock. They grow best in an open, unshaded situation.

There are over 300 species of willow, having the widest natural geographical distribution of any tree - right across the northern hemisphere and South America and South Africa. About a dozen species will grow into timber - sized trees, the others remain as small trees or shrubs. A great number of hybrids have been produced in natural populations and many more have been obtained artificially. Willows are very fast growers and many have foliage which is edible to livestock. (Weeping willow - 15.9% crude protein, 2.9% crude fat, 18% crude fibre, 1.6% calcium, 0.27% phosphorous and 10.2% ash.) "New Zealand trials have shown the hybrid willow to produce more than 30 tonnes of dry matter yield per hectare, whereas good grass or lucerne stands yield only 10 to 15 tonnes per hectare. Tree crops however also allow grass to grow beneath." (Ref. Thamo. A. "Fodder Trees" from "Trees for Farms").

Willows can be either cut and carried to stock, established as lock up self forage systems or in the case of the weeping trees, stock can only trim what grows down to their reach.

Willows are extremely good bee forage plants, providing both nectar and pollen, at a time when few plants are flowering. They may also have medicinal properties. It is said that the American Indians were able to lower fevers by drinking an infusion of willow tree bark. The bark has also been used traditionally as a cure for rheumatic complaints. One of the active ingredients of willow bark is salicin which relieves pain and stiffness in the joints. Acetyl - salicylic acid, better known as aspirin, is one of its derivatives.

Willows strike readily from cuttings taken at any size, in fact so strong is the rooting hormone that it surpasses commercial rooting powders as a means of encouraging cuttings from other plants to establish roots. Willow cuttings placed in a bucket of water will develop roots after about a week. Any cuttings from other plants, allowed to soak in this same water overnight, will have greatly increased chances of developing roots. Those cuttings should then be placed in cutting beds in the usual manner.

Young willows should be planted so their roots are above the winter groundwater table. The best sites for planting willows are summer moist or sites not far from the water table. Willows may need summer irrigation until their root systems reach ground water. Trees can be planted reasonably close (2 m) if they are to be kept cut or up to 5 m apart for full sized trees.

***Salixalba* (white willow)**

This species can obtain a height of 30 m and is able to grow on all types of soil, including compacted, swampy, acid or alkaline, provided the roots have sufficient moisture. However, for a good yield of timber, a fertile soil is necessary It used to be commonly found around the margins of moist meadows in Europe, and was pollarded to produce firewood at regular intervals. It can be used for the same purposes as the white poplar, although the wood is more coloured.

***Salixalba 'Coerulea'* (cricket bat willow)**

A female cultivar yielding a timber which, although light in weight, can withstand sudden impact and as its name suggests is used to make top quality cricket bats, a unique industry. The trees require good soil by stream sides to give exceptionally rapid and **upright** growth, ready for cutting from 12 to 15 years. This timber also shows potential in the craft industry.

***Salix babylonica* (weeping willow)**

Probably the best known of all willows, with its "weeping" habit. Originally from the Far East, it was introduced to Europe more than two centuries ago and then spread throughout the world. It is a small tree, reaching 10 - 15 m in height, cultivated specimens being exclusively of the female sex. Because of its relative sensitivity to cold, its hybrids with *S. alba* and *S.Jragilis* are often grown in temperate regions.

Salix humboltii

Native to South America in warm temperate and subtropical regions. Common in Argentina where it has some economic importance and is used in land reclamation projects.

Salix matsudana

The New Zealand bred hybrids are a cross of Chinese, European and South American willows and will grow to 3.6 m in the first season after planting, given reasonable conditions. The variety "tortuosa", is a female clone where the branches are twisted, hence the name "corkscrew willow".

***Salix viminalis* (osier willow, basket willow)**

In Europe, the osier willow is specifically grown and specially harvested for the basket and willow weaving trade. Cultivars have been developed to produce different coloured and textured 'rods'. "Osier stool beds are raised from cuttings and harvested annually as rods, most of these are peeled but some are used with the bark on. The conversion of these rods into baskets, furniture and fish traps is a highly skilled trade many hundreds of years old, and happily by no means dead yet." (Ref. Edlin H., Nimmo L. et al. "The Illustrated Encyclopedia of Trees - Timber and Forests of the World". Leisure Books 1978). There is considerable potential for this tree in a country like Australia which imports all of its commercial cane.

POPLARS (Populus spp)

Family: SALICACEAE

Poplars generally use large amounts of water, will grow adjacent to waterlogged soil and have root systems that have been known to reach out as far as 50 m laterally in search of moisture and nutrient. For this reason, they are extremely good trees for, erosion and for salinity control, but should not be planted close to gardens, septic systems and orchards. Some poplars will tolerate prolonged periods of flooding. They are fast growing, yield a soft, light timber, and provide useful fodder for stock. They grow best in an open, unshaded situation.

The foliage of poplars is extremely nutritious as a stockfeed. Not only will stock eat all the foliage they can reach, including any suckers shooting up from the parent tree roots, but also eat the leaves that fall in autumn. Poplar foliage is superior nutritionally to lucerne.

Composition of Lucerne, Fodder Grasses and Poplar Leaves..

Expressed as a percentage (Food and Agriculture Organisation)

Constituents	*Lucerne*	*Grass*	*Poplar Leaves*
Water	74.0	80.0	60.0
Minerals	2.0	2.0	4.0
Fats	1.0	1.0	**2.0**
Nitrates	4.5	3.5	6.0
Non Nitrogenous Extracts	9.0	9.0	5.0
Cellulose	9.5	4.5	5.0
Total	**100.0**	**100.0**	**100.0**

"A Hunter River farm in New South Wales, 40 hectares of river flats, was progressively planted to wide spaced poplars for timber production, with the branch and leaf material from the pruning of the trees being fed to beef cattle. At the outset of the plantings, it was hoped to be able to hold cattle numbers constant, despite the trees, because of these prunings. However, in reality, it was found that numbers could be increased by 20%. There was more summer grass due to the humidifying and sheltering effect of the trees and more winter grass because the trees, even without their leaves, kept the site warmer. The poplars reached timber harvest size in just 15 years. The overall increase in productivity was startling." (Ref. Thamo. A. "Fodder Trees" from "Trees for Farms").

In Maine, USA, poplar wood is being chipped and steamed to provide roughage feed for sheep and cattle at US $35/tonne (1981 prices). "As a maintenance ration, the steamed poplar can satisfy about 65% of a dry sheep's requirements". (Ref. White. T. "Poplars and Pampas" from Permaculture Journal, issue 7, March 1981).

In Dungong in N.S.W and at Darville in South Africa sewerage effluent water is used to irrigate poplar plantations. The poplars are sold to match companies and provide a lucrative return to the two municipalities.

Poplar wood is soft, suitable for wood pulp and paper, although it is also used for a wide variety of other purposes. First quality wood is used in furniture manufacture, for the interiors of cupboards, sideboards and for shelving. Poplar wood can also be used in construction work, for framework and roofing timbers, providing it is not subject to too great mechanical stresses and is protected from the elements. Other uses of poplar wood include matches, fruit boxes, plywood, fibreboard, chipboard, woodwool, packing cases, flooring, kitchen utensils, wooden toys, drawing boards and tables and rough boarding. Poplar wood does have a tendency to defects due either to insect or fungal attack, anatomical structure, or internal growth stresses, which lessens its commercial value.

Poplars can be propagated from cuttings, like willows. They can even be established from cuttings 10 m high, provided they can access water. Cuttings taken from young trees strike root more easily than cuttings taken from older trees, and the terminal shoots are generally not suitable. Experiments in propagating *P. deltoides* in the USA have shown marked seasonal variations, autumn being the most successful time, winter also being satisfactory. Phosphorus has also been shown to have a good effect on root development.

Willows and poplars can be planted around the edge of salt scalds, and trials to establish trees on soil mounds in the scalds could be rewarding. The suckering, salt tolerant varieties of poplars may even 'colonize' such scalds.

Being deciduous trees, willows and poplars are not effective windbreak species for winter winds but can be planted to shelter from hot summer winds. Being deciduous, however, allows a range of understorey, including the perennial bana grass, elephant grass, pampas grass and bamboo, to make growth over the winter months.

Good companions to the willows and poplars are any of the useful nitrogen fixing legumes, tolerant of the same conditions, (eg *Acacia saligna* for fodder and *Acacia melanoxilon* for first grade furniture timber).

***Populus alba* (white poplar)**

Grows to 30 m, is ornamental, wide crowned and is characterised by the silvery white underside to the leaves. It has a strong suckering habit and is tolerant of soil salinity, salt spray and drought, although traditionally associated with the presence of water. It is adapted to warm, dry continental climates and prefers soils rich in minerals.

Although a good volume of timber can be obtained from suitable sites, the properties of the wood of some cultivars are not satisfactory - the yield of cellulose is poor, and there is much abnormal wood. The wood is used for planking and packing, or as supporting parts in furniture made from finer woods.

Green leaf protein - 14.4%, digestibility - 77.7%.

Propagated by seed, radical suckers or cuttings. Ability to propagate from cuttings is variable.

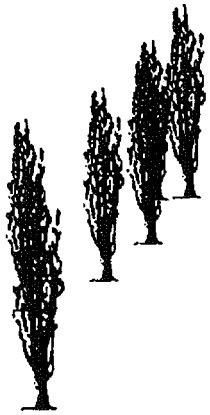
***Populus euphratica* (Euphrates poplar)**

Occurs naturally in soils with a high salinity (as much as 3000 ppm), and is remarkably tolerant of high temperatures. Its distribution extends from the Altai mountains (45°N) to the equator, implying a high degree of adaptability to a very wide range of conditions.
A good fodder tree (green leaf protein - 11.2%, digestibility - 67.1%) and an easy to saw wood, which works to a good finish. It is a good turnery wood and can be peeled on a rotary cutter, making it ideal for plywood. It is a good pulp wood which coppices readily.

Spreads from root suckers and does not propagate well from cuttings.

***Populus deltoides* (cottonwood)**

Native to North America, and grows to 25 - 30 m. It is fast growing, reaching full height in 20 years, and provides abundant wood for the production of cellulose. A pioneer species in company with willows on flooded soils, it is suited to most fertile soils in cool districts receiving at least 650 mm mean annual rainfall. Propagation is from seed and cuttings.



***Populus nigra, 'Italica'* (lombardy poplar)**

Grows to 40 m, is narrow, columnar, with close, erect branches, particularly suited to forming a tall windbreak or screen. It has a suckering habit, is very fast growing and is suited to most soils in areas receiving at least 550 mm mean annual rainfall. Very adaptable to a wide range of ecological conditions.

Green leaf protein - 14.3%, digestibility - 77.0%. The timber is used in the manufacture of sawn packaging.

Propagation from cuttings only, as most Lombardy poplars are male.

***Populus simonii,'Fastigiata'* (Simon poplar)**

Grows to 12 m, is erect, non suckering and prefers acid - neutral soils in districts receiving at least 550 mm mean annual rainfall. A suitable coastal tree, capable of withstanding strong winds.

Nutritional composition Simon poplar: green leaf protein - 12.2%, digestibility - 76.8%.

***Populus yunnanensis* (Chinese poplar)**

This fast growing tree (to 20 m), has an open, round, spreading crown which produces filtered shade, has a few suckers, and grows in acid - neutral soils in areas receiving at least 550 mm mean annual rainfall. Some cultivars are very drought resistant.
Used in the south west of Australia as fire breaks around pine plantations. The autumn leaf fall is later than other poplar species.

Easily propagated from cuttings.

***Populus x canescens* (grey poplar)**

A result of crossing the white poplar and the aspen. A suckering tree with silvery leaves, it produces a smooth, non - splintering, non - warping, lightweight wood which has many uses from silk - rollers to doors.

Populus x euramericana (Euramerican poplar)

This hybrid was obtained by crossing the European *Populus nigra* with the American *Populus deltoides.* Different cultivars have individual characteristics some of which are renowned as fast growing, attractive ornamentals, very good timber trees and producers of large leaves. They are free from burrs (the main defect of *P. nigra),* are disease resistant and generally propagate from cuttings better than *P. deltoides.* They prefer deep, light, well - watered soils, or river banks and alluvial plains. Green leaf protein - 13.3%, digestibility - 74.0%.

CASTOR *(Ricinus communis)*

Family: EUPHOBIACEAE

A large bush to small tree (0.9 - 4 m tall and spreading to 2 m), it does best in dry, hot regions with an annual average rainfall of 380 - 500 mm, and is frost and drought tolerant. It is adaptable to a wide range of soils but prefers coarse, open textured soils and grows poorly on badly drained or saline soils. It has become a common weed of the coastal area around Perth, Western Australia.

The seeds are poisonous to animals (including humans), but are the commercial source of castor oil. Oil content of seed varies between 35 - 55%. The oil is important in industry and pharmaceuticals. It does not solidify at low temperatures and retains its viscosity at high temperatures. It is a great lubricant and an important part of hydraulic fluids, and is a good oil for leather dressing to make it pliable and soft. It is used in the manufacture of soap, candles, hair oils, cosmetics, perfumes, fly paper and poison, typewriter ink, cutting oil, linoleum rubber substitutes and artificial leather. It is used in the manufacture of Roghan to make wax cloth and in the manufacture of Turkey red oil for dyeing and printing cotton and woollen fabrics. It is also used in the finishing of cotton, silk, linen and leather. It is used in wood oils. The natives of Ecuador string the seeds and burn them as candles. The oil cake is valued as a manure. The stems are good for paper making and the leaves are an important food of silkworm. It is a valued bee forage.

The cold drawn oil is regarded as one of the most valuable laxatives in medicine, but should not be used in cases of severe constipation. It is an effective purgative, an excellent evacuant for children, as an enema mixed with soapy water and is applied locally for conjunctivitis. It is dropped into the eye to relieve the irritation caused after removing foreign bodies. Mixed with citron ointment it is used as a topical application in common leprosy. The seed also contains ricin, a toxin which is a blood coagulant and an enzyme, lipase.

A poultice of the leaves can be applied to boils and swellings. Coated with a bland oil the hot leaves are applied across the abdomen of children to relieve flatulence, over the pubic area of women to promote menstruation, over the breasts to soothe inflammation during lactation, and over Guinea worm sore to remove the worm.

In narcotic poisoning, the juice of the leaves is given as an emetic. A leaf decoction is an emmenagogue, purgative and a lactagogue. The root is made into a paste and applied for tooth - ache, made into a decoction with added carbonate of potash to treat lumbago, rheumatism and sciatica. These last three ailments are also treated by giving a paste of the seed without the embryo and boiled in milk.

CAPE LILAC *(Melia azedarach)*

Family: MELIACEAE

Other common names include: azadarach, white cedar, China berry, bead tree, Indian lilac, pride of China. A medium sized (6 - 30 m and 50 - 80 cm diameter) deciduous tree, native to south Asia, Mexico and Australia. It is drought hardy and grows well in areas with 600 - 1,000 mm of rainfall or in drier areas along water courses or when irrigated as is done in the Middle East for firewood. Best suited to a deep, well drained, sandy loam, but adaptable to a wide range of soils. Young trees can be killed by frost but mature trees are resistant to temperatures as low as -15°C.

It seeds prolifically which has caused it to have somewhat of a poor reputation as a garden tree, although the flowers and scent have been the major attraction in planting. The tree is said to be fire retardant and is a valuable bee forage. The wood is moderately soft, is weak, brittle, and susceptible to termite damage but is used for tool handles, cabinet making, furniture, face veneers, turnery, cigar boxes and the manufacture of writing and printing paper.

It coppices readily and is a source of firewood. The leaves are used as fodder for goats.

An exciting use of this tree is as an insecticide. The leaves, seeds and fresh fruit contain azadarachtin, a naturally occurring insecticide for which the neem tree, a close relative of *Melia azedarach* has become famous. Azadarachtin is a systemic pesticide which is absorbed into a plant and works from within. Most insects will starve before eating plants treated with azadarachtin. It also appears to be repellent to nematodes and is effective in protecting stored food from pests. The oil is effective protection from head lice (but is claimed not to be dangerous to humans) and poured on water, wilt kill mosquito larvae (but is claimed not to be dangerous to fish, although the Australian Aboriginals use the bark and leaves as a fish poison). The fruits have been used as a flea powder.

Medicinally the root bark is made into a decoction and acts as a purgative and emetic, especially in large doses, and is also used to promote the onset of menstruation and is said to be cathartic, and in large doses slightly narcotic. The bark is bitter and astringent and is used in India as a tonic and is used as a remedy for hysteria. The seeds and oil of the fruit promote the elimination of worms. 60 grams of bark to 750 ml water and boiled down to 375 ml, one teaspoon every 2 - 3 hours or 20 grams of powdered bark for an effective dose against worms. A gum extracted from the tree is used for spleen enlargement.

Seed oil is used for soap making and hair oils,

The Hindu considers it as a stomachic and taps it for toddy. The seeds are used for rosary beads.

Angoumis grain moth *(Silophilus oryzae):* ether and petroleum ether extracts of the fruit are toxic to this pest.

Cabbage worm *(Pieris brassicae):* dust leaves with powdered fruit or 50 - 100% water extract spray.

Fungi *(Heminthosporium spp* and *Alternaria tenius)* inhibited by cold water leaf extract.

Grasshoppers and locusts: 2% powdered fruit in suspension in water acts as an antifeedant in grasshoppers *(Chrotogonus trachypterus)* and dusting crops with the dried seed powder inhibits feeding of desert locusts *(Schirtoceroa gregaria)* and migratory locusts *(Locusta migratoria).*

Mosquito larvae: killed by seed oil at 250 ppm.

Nematode *(Meliodogyne gavanica)*: green leaves applied to the soil.

Painted bug *(Bagrada cruciferarum):* spraying a 2% petroleum ether extract of leaves and seeds.

Rice weevil *(Sitophylis oryzae)*: 2.5-5 parts powdered fruit of cape lilac to 100 parts grain protects the stored grain for 4 months or the leaves can be mixed with the grain.

Tobacco cutworm *(Spodoptera litura)*: extracts of fruit.

NEEM *(Azadirachta indica)*

Family: MELIACEAE

A deep rooted, broad leafed tree which is usually evergreen but may lose its leaves during drought. A native of the dry forests of India through to Burma, it is potentially among the most valuable of arid land trees. It usually occurs in areas of 450 - 1150 mm average annual rainfall, but will tolerate annual rainfalls as low as 130 mm. It can tolerate long, dry seasons and great heat but is not frost hardy. It will grow on most soils including dry, stony, clay and shallow soils but not seasonally waterlogged soils (where the taproot rots and the tree dies off) or deep dry sands where the water table lies below 18 m. The roots seem to be able to extract nutrients from the most leached of sandy soils. Its optimum soil pH is 6.2 although it will grow well at pH 5, actually bringing soil to a neutral condition by leaf litter. It is not tolerant of saline soils.

The seeds and leaves yield azadarachtin and is used as described for *Melia azedarach.* The wood is similar to Cuban mahogany and resists decay and insects and is tougher than teak. The tree coppices readily and the poles are straight and strong. It is excellent for construction and furniture making. Termite attack is rare. It is a valuable source of firewood having almost as high a calorific value as coal.

In India it is one of the five trees planted in the sacred grove where it is planted as a companion to mango and *Ficus religiosa.* There, the leaves are dried and placed in books, grain and clothes to repel insects. The twigs are used as toothbrushes, the bark made into a decoctipn for fevers, nausea, liver complaints and jaundice, or made into a poultice for wounds and skin diseases. Bark oil is used as a rub for rheumatism while the fruit is steeped or crushed and used for urinary complaints, piles and worms. The fruit is considered a purgative and an emollient. The oil from the seed is rubbed onto the body as a cure for skin diseases.

Propagation is by seed, but the seed is very short lived (2 or 3 weeks). The seedlings are killed by frost and fire and need to be kept free of weeds.

INDIAN BEECH *(Derris indica)*

Family: FABACEAE/PAPILIONACEAE

Also known as derris, oil tree, pongam, ponga, kona, kanji, paripari, karanda and karanja, this is a leguminous medium - sized, deciduous, thornless tree (to 8 m) with spreading or drooping branches. Originally native to India, it is now widely distributed throughout the world. It is considered fast growing, reaching mature height in 4 - 5 years.

Mature trees withstand temperatures from below 0°C to 50°C and thrive from sea level to 1200 m altitude. They require a rainfall from 500 - 2,500 mm and grow wild on sandy and rocky soils. They will grow on most soil types, including limestone and are highly tolerant of salinity even with the roots in salt water.

It is a valued livestock tree, especially in arid areas. Grasses grow well in its shade, and the foliage is probably high in protein.

The seeds contain a yellow or red - brown oil (30 - 40%) which is not edible but can be used as a lubricant or as a fuel for kerosene lamps. It is also used as a leather dressing, in soap manufacturing and in varnishes and paints. It is also reputed to have antiseptic value in treating human and animal skin diseases.

The dried leaves have an odour which repels insects and are used to protect stored grain from insects. They are also ploughed into the soil as a green manure and are said to repel nematodes. The presscake left after the oil has been extracted is sought after by Indian farmers as an insecticide and has also been demonstrated to be a good poultry feed.

The bark fibre is used to make rope which is very strong, and the wood is a good firewood with a calorific value of 4600 kcal\kg. The wood is coarse textured and although somewhat difficult to work is often used in cabinet making because of its beautiful grain. It is also used for making cartwheels and posts.

The seeds remain viable for a long time and it grows readily from cuttings of all sizes. The seedlings transplant easily. The root system is extensive at the surface and it suckers readily. It creates a lot of litter from leaf, flower and pod drop.

COTONEASTER *(Cotoneaster spp)*

Family: ROSACEAE

Cotoneasters are a group of shrubs that are members of the rose family. The genus comprises about 50 deciduous and evergreen shrubs, ranging from ground cover to shrubs, some reaching up to 20 m in height. They are all hardy, tolerating minimum care and fairly dry conditions. Most species have arching, thornless branches, grey - green leaves, white flowers and red berries in the autumn. Plants are usually grown from seed, although cutting - grown plants will commence fruiting about 2 years earlier. Cotoneasters can be planted as part of a chicken forage system, as the berries are edible to chooks. They will also act as a lure to parrots, keeping them away from fruit trees.

DOGWOOD *(Cornus capitata)*

Family: CORNACEAE

A hardy evergreen shrub which grows into a robust small tree to 4 - 9 m in height. It is native to the Himalayas and is sometimes referred to as the strawberry tree because of its strawberry - like fruits, but should not be confused with *Arbutus unedo,* which is also called the strawberry tree. Other common names include thammal and thanboi. It is easily grown in reasonably good soil and will readily withstand frost, although flower buds may be damaged by excessive winter cold. It makes a good quick - growing shelter belt and responds to clipping. The shrub is also a fire retardant.

The berries which are produced in late autumn, measure 2 - 5 cm and are one - sided, fleshy, strawberry - like fruits of a dull red colour. The shrub can be included in a chicken forage system as the berries are popular with chooks.

COPROSMA *(Coprosma repens)*

Family: RUBIACEAE

Also called taupata by the Maori people and New Zealand mirror plant because of its shiny leaves, this dioecious shrub to small tree (up to 5 m) naturally occurs on coastal dunes. The plant is adaptable to most conditions and spreads naturally by layering. Once established it is able to withstand drought and frost. It can utilise nutrients from salt spray. As a hedge it makes a very dense windbreak. It is one of the most effective fire retardant plants, making a good radiation shield.

Poultry relish the orange berries which fall to the ground. The foliage is a good stockfeed. It can be propagated by seed and good producing females can be selected and further propagated by cutting and layering.

HORSERADISH TREE, DRUMSTICK *(Moringa oleifera)*

Family: MORINGACEAE

A small (to 8m tall and 3 m wide), deciduous tree, native to India. It is both drought and frost tender.

The long bean - like fruit is used in soups and curries. The young leaves and twigs have a mustard flavour and are eaten in salads. The immature seeds are used like peas, the mature seeds are roasted or fried and eaten like peanuts. The root is used like horseradish. Young tender seedlings are cooked as a vegetable. The leaves contain 7 - 10% protein.

The fruit produces a seed which yields an oil which never goes rancid. Called behen or ben oil it is used for salads and for cooking.

The oil is also known as watchmakers oil because of its use in delicate precision machinery.

CHINESE TALLOW TREE *(Sapium sebiferum)*

Family: EUPHORBIACEAE

A native of the Far East, this species is a deciduous, fast growing, disease resistant tree, which rarely attains heights greater than 8 m and width of 5 m. It tolerates a wide range of soils, including poor drainage and saline soils. It will grow from the coast to elevations of 2000 m. It is drought tolerant and also tolerant of frost, and in the dormant state will withstand brief lows of - 10 °C. It is generally considered to be a high moisture plant and trees have survived for more than 2 years in areas flooded by dam construction. Its lower rainfall tolerance is probably somewhat below 500 mm.

Fruiting capsules consist of 3 seeds each covered with a white vegetable wax. This coating is used for soap and making candles in its native China. The wax can also be used as a substitute for lard or cocoa butter. In autumn the foliage turns a brilliant mixture of red and bronze, even in warmer areas where other trees remain green. This colour contrasts well with the white, wax - coated seeds.

It is a good firewood (4134 - 4277 kcal/kg), the dry wood burning well and producing a pleasant odour. Over a 4 year growing season, firewood yields averaged 22 cubic metres/ha/year. Roots and stumps cut at any time of the year coppice prolifically (26 cubic metres/ha/year has been recorded). The wood has been used for making implement handles as well as for carving. It is not a good external timber, but may be suitable as pulp. It is a major honey and pollen plant. The honey is moderately dark and exceptionally flavourful.

MOUNTAIN ASH, ROWAN *(Sorbus aucuparia*, syn. *Sorbus edulis)*

Family: ROSACEAE

A handsome, slender tree, growing to a height of 10 m, which is native to the cool, temperate regions of the northern hemisphere. A very hardy tree and frost tolerant. Grows at altitudes of up to 1000 m in Scotland, higher than all other species. The early spring flowers are white, similar to hawthorn, and the fruits are bright red, up to 1 cm in diameter, and hang in large clusters all over the tree, remaining there until autumn, when the foliage turns a golden yellow. The berries can be used to make an unusual smoky flavoured jelly, preserves, wines, and added to soups. They are made into a coffee substitute and the leaves and flowers are used to adulterate tea. The timber is tough, with a reddish brown heartwood. It is used for tool handles, carving and turnery.

BOX ELDER MAPLE *(Acer negundo, syn. Negundo aceroides)*

Family: ACERACEAE

Native to eastern and northern North America, this species grows to 20 m. It is deciduous, dioecious and fairly fast growing. It prefers well drained and slightly alkaline soils.

It has fire retardant properties, is a good bee forage plant and the foliage is readily eaten by cattle and pigs. The sap can be tapped for maple syrup, the sugar from which is said to be whiter than any other maple sugar. It will coppice readily and can be maintained as a large shrub.

CEDARS *(Cedrus spp)*

Family: PINACEAE

A large, spreading, evergreen tree which grows in temperate uplands.

All cedars require a deep, rich soil and particularly a porous subsoil for maximum growth. Although often claimed to be slow growing, the cedars can attain rapid growth in ideal conditions (up to 16 m in 30 years). They generally suffer few fungal diseases but are susceptible to drought.

All of the cedars produce excellent quality timber. Valuable essential oils are extracted from the fragrant wood.

They should not be planted near buildings.

Cedrus atlantica (Mt. Atlas Cedar)

A native of the mountainous region of Algeria and Morocco, this species has reached heights of 50 m, with a girth of 1.5 m, and can grow to 13 m in 20 years. In minimum rainfall areas, it only reaches heights of 10 - 20 m. It prefers deep moist soils and does best in cool climates in Australia (mild climates with a humid atmosphere). It occurs naturally on limestone soils, but has adapted well to slightly acid soils. It is very resistant to pollution.
The timber is excellent for carpentry, and the strong smell keeps insects away.

***Cedrus deodara* (Deodar Cedar)**

A native of the Himalayas and Baluchichistan, at 1100 - 4000 m. It reaches heights of up to 70 m, with a girth of 1.5 m, and can grow up to 15 m in 20 years. It prefers deep moist soil and does best in cool climates in Australia, with a minimum rainfall 650 mm, but is a very adaptable tree. In the USA it is grown in California and the south.

The timber is used in Asia for the construction of temples, and was used in Egypt for making sarcophagi for mummies. Cedar oil is extracted from the wood.

***Cedrus libanii* (Cedar of Lebanon)**

Native to the Cicilia and the Taurus Mountains and the mountains of Lebanon, this cedar grows to 10 - 20 m. It prefers deep moist soil and does best in cool climates in Australia. It is not frost tolerant. Although it can be very long lived (2,500 years), it rarely lives beyond 1000 years.

It is of little economic importance because of its slow growth, but can grow up to 9m in 20 years. The timber is very durable and used for fine joinery and veneers and has a strong scent. King Solomon built his temple with the timber of this species, destroying much of the native stand in the process.

EUCALYPTS *(Eucalyptus spp)*

Family: MYRTACEAE

Eucalypts should be grown in association with acacias and other nitrogen - fixing trees. As eucalypts generally have highly invasive root systems that can rob adjacent land of water and nutrients, they should have a buffer of nitrogen - fixing trees between them and crop land or pasture.

Most eucalypts coppice readily. They are planted extensively as a firewood crop, but in many parts of the world their invasive root systems have led to serious nutrient loss in the soil. In some instances farmers have walked off the farms that have supported their families for many generations.

Eucalyptus oil is usually extracted from leaves of trees managed by coppice.

Thinning can be used for fence posts, construction poles and some species can be sold for pulp. Using these chip species to encourage timber species to form long, straight trunks is a means of supplementing farm income before the timber species mature.

As the world supplies of hardwood diminish, eucalypts promise a worthy investment for the future.

Many species of eucalypts are also significant nectar producers to incorporate in a bee forage system.

***Eucalyptus albens* (white box)**

A tall tree to 25 m, with a diameter up to 1 m. It occurs in all eastern mainland states of Australia in rainfall areas of between 500 - 700 mm. It prefers higher slopes.

The wood is heavy, dense and used for sleepers, heavy engineering and poles.

***Eucalyptus cafophylla* (marri, red gum)**

The best known and commonest of Western Australian forest trees. It typically grows to 40 m (up to 60 m) and is tolerant of a wide range of soil types and conditions, including frost and drought.

It is the major honey producer of Western Australia, supplying a good honey flow from January through to March. The flowering time can be extended in managed coppice lots. The timber is not used in contact with the ground or in situations exposed to the elements but it is strong, durable, non - fissile and easily worked, although marred by gum pockets. Gum pockets are minimal when the tree has not been exposed to fires. It has a density of 850 kg/cu/m. It is used for tool handles, sporting goods, furniture, packing cases and is the major native paper pulp species in WA.

Eucalyptus cornuta (yate)

A tall tree to 25 m, with diameter to 1 m, the yate is indigenous to the coastal belt from Busselton to east of Albany in Western Australia. The average rainfall ranges from 700 - 1400 mm. The closely related *Eucalyptus macrocera* occurs in the Stirling Ranges in a slightly lower rainfall area.

It usually occurs as scattered trees in open forest. Its companion trees include; jarrah *(Eucalyptus marginata),* marri *(Eucalyptus calophylla),* tuart *(Eucalyptus gomphocephala)* , Western Australian flooded gum *(Eucalyptus rudis),* Mt. Le Grand mallee *(Eucalyptus aquilina)* and Bald Island marlock *(Eucalyptus lehmannii).*

The timber is very durable and reported as one of the hardest and strongest timbers in the world. It was formerly used for wheelwright work, but is now of very limited availability. One south west manufacturer of musical instruments reports that stringed instruments made from yate have an excellent sound quality.

Eucalyptus eremophila (tall sand mallee)

Native to Western Australia, this tree attains an average height of 5 m, with several stems from the base. When grown in cultivation it can grow as a single stem to 7 m. It exists on loamy soils and is frequently found on the margins of salmon gum forests in open thickets. It occurs in areas with an average annual rainfall of 200 - 500 mm and is frost tolerant. It grows in most soils including salt affected ones.

It produces an abundance of pollen from June to October and sometimes as late as January It is considered a good street tree in arid conditions. Being relatively small it does not interfere with power lines but is attractive in full flower, having both a yellow and red flowering form.

Eucalyptus gardneri (blue mallet)

A small eucalypt to 6 - 9 m with a straight trunk and bushy crown. It is fast growing and tolerant of severe drought and frost. The average annual rainfall is typically between 330 - 350 mm.

It is a good source of winter honey. The bark contains up to 30% tannin and the straight trunks are used as poles, rails and in buildings. The wood is light coloured, hard and dense.

Eucalyptus gomphocephala (tuart)

A tall tree (25 - 40 m with diameters of 1 - 2 m), the tuart's natural occurrence is restricted to a very narrow belt of coastal South Western Australia (rainfall 800 - 900 mm). It has, however, proven in trials, to be very adaptable to different soil and rainfall regimes. It does especially well on sandy soils. In trials in Esperance it has outgrown pines and is also reported to be doing well at Corrigin (300 - 400 mm rainfall). Tuart is widely planted throughout the world to stabilise sand dunes and for wind protection (it is wind firm). It will tolerate slightly saline soils but not waterlogging.

Its natural understorey species are Swan River peppermint *(Agonis flexuosa),* sheoak *(Casuarina fraserana)* and various banksia species. Its companion trees include; jarrah *(Eucalyptus marginata),* marri *(Eucalyptus calophylla),* yate *(Eucalyptus cornuta)* and Western Australian flooded gum *(Eucalyptus rudis).*

The wood seasons well, is very hard, strong, tough and very durable and relatively termite resistant. It is one of the densest known woods. It is a good timber for exposure to weather and has been sought after for use in carriages and truck trays. It was used in ship building and bridge construction because of its strength.

Eucalyptus largiflorens (black box)

Small to medium sized tree, (10-20 m), reaching diameters of 1 m. It grows principally on flat country along water courses in rainfalls of 200 - 300 mm. It usually occurs on clays that are close to the surface and subject to poor drainage.

It is an open woodland tree. Companions include; river red gum *(Eucalyptus camaldulensis),* myall *(Acacia pendula),* cooba *(Acacia salicina).*

The pink to reddish brown wood is hard, heavy and durable and is used for posts, small poles and sleepers. It makes a good firewood.

Eucalyptus leucoxylon (South Australian blue gum, yellow gum)

This 10 - 16 m woodland tree may attain heights to 30 m in a forest situation, with diameters up to 0.8 m. It is native to South Australia and Victoria in rainfall areas between 400 - 800 mm.

Natural companions include *Casuarina stricta, Banksia marginata, Acacia calamifolia, Acacia pycnantha, Eucalyptus odorata, Eucalyptus fasciculosa, Eucalyptus viminalis, Eucalyptus huberana, Eucalyptus foecunda, Eucalyptus cladocalyx* and *Eucalyptus goniocalyx.*

The wood is hard, strong, dense and very durable. It is used for sleepers, building, framing, construction timbers, poles and structural engineering.

Eucalyptus loxophleba (York gum)

A small tree (5 - 15 m tall, up to 0.6 m diameter.) A native of the Western Australian wheatbelt and goldfields, with rainfalls from 250 - 750 mm.

Its companions include: wandoo *(Eucalyptus wandoo),* salmon gum *(Eucalyptus salmonophloia),* gimlet *(Eucalyptus salubris),* powder bark wandoo *(Eucalyptus accedens),* capped mallee *(Eucalyptus pileata)* and square fruited mallee *(Eucalyptus calycogona).*

The wood is very dense, hard and tough, with a closely interlocking grain. It was used for wheelwright and similar work, but is no longer available in commercial size.

Eucalyptus maculata (spotted gum)

A tall tree, to 35 m, with a diameter to 1.3 m. It is native to Queensland, New South Wales and Victoria in rainfalls ranging from 750 - 1700 mm.

It naturally occurs in open to tall open forest, often in almost pure stands. Companions can include: *Casuarina spp, Acacia spp, Callitris spp, Angophora spp Eucalyptus crebra, Eucalyptus pillularis,Eucalyptus microcorys, Eucalyptus propinqua, Eucalyptus punctata, Eucalyptus paniculata, Eucalyptus saligna, Eucalyptus moluccana* and *Eucalyptus acmenoides.*

Said to be one of the most suitable Australian timbers for tool handles, the wood is moderately durable and shock resistant. It is also used for poles and plywood manufacture. The spotted gum is also said to be fire retardant.

Eucalyptus melliodora (yellow box)

A medium sized tree, 15 - 30 m tall and up to 1 m in diameter. This native of eastern Australia grows in 500 - 900 mm rainfall areas. It occurs on gentle slopes and foothills, but is restricted to river flats and watercourses in drier areas.

Companions include: red box *(Eucalyptus polyanthemos),* white box *(Eucalyptus albens)* and grey box *(Eucalyptus microcarpa).*

The wood is very hard, heavy, strong, extremely durable and has a fine texture and interlocked grain. It is used for heavy engineering, sleepers, poles, fence posts and is an excellent firewood.

Eucalyptus microcarpa (grey box)

A medium sized tree, to 25 m, reaching diameters of 1 m in rainfall areas of 400 - 700 mm. It- is native to all of the mainland eastern states of Australia. It prefers heavy soils, clay loams and better quality sandy loams.

It occurs in woodland with yellow box *(Eucalyptus melliodora),* red box *(Eucalyptus polyanthemos),* river red gum *(Eucalyptus camaldulensis),* yellow gum *(Eucalyptus leucoxylon),* red ironbark *(Eucalyptus sideroxylon),* brigalow *(Acacia harpophylla)* and various *Casuarina spp.*

The wood is extremely durable, hard, strong and has a fine textured grain. It is used for fence posts and sleepers.

Eucalyptus muellerana (yellow stringy bark)

A tall tree to 40 m and 1 m diameter. Rainfall ranges from 700 - 1200 mm. It requires good drainage but grows on a wide range of soil types and is best suited to deep clay loams. It prefers moist valleys and sheltered slopes.

It is one of the best honey producing eucalypts. The wood is heavy, hard, strong and durable. It is used for wharves and bridge construction, posts and poles, general purpose construction, flooring and sleepers and is grown also for pulp wood.

Eucalyptus obliqua (messmate)

A tall tree to 90 m, with diameter to 3 m. It occurs on poor soil in rainfalls of 500 - 1240 mm.

Used for flooring, furniture, panelling, joinery, general purpose construction and house building. It is easily glued, stained and worked and is one of Australia's most important hardwoods.

Eucalyptus occidentals (swamp yate)

A medium sized tree (to 20 m tall and diameter 0.5 m), occurring in swamps along the south coast of Western Australia. The rainfall range is 300 - 800 mm. It can thrive near salt lakes and in some areas it is notably salt tolerant.

It occurs in woodland in association with York gum *(Eucalyptus loxophleba),* open fruited mallee *(Eucalyptus annulata),* silver mallet *(Eucalyptus falcata),* tallerack *(Eucalyptus tetragona)* and limestone marlock *(Eucalyptus decipiens).*

Of the eucalypts, it is considered a good shade tree as light can penetrate the sparse canopy permitting grasses to grow right to the trunk.

It is said that the sap can be tapped for sugar.

The wood is a high quality timber of use in construction and for products requiring heavy and strong wood. As a firewood it burns with a hot fire.

Eucalyptus patens (yarri)

A tall tree to 45 m and 1.8 m diameter, yarri is also known as Western Australian blackbutt. It extends in a belt from Perth to Albany in the rainfall range of 850 - 1250 mm.

It occurs in the moister areas of tall open forest, in association with marri *(Eucalyptus calophylla),* karri *(Eucalyptus diversicolor),* jarrah *(Eucalyptus marginata)* and Western Australian flooded gum *(Eucalyptus rudis).*

The wood is hard, tough, moderately durable and is used for construction work, flooring and panelling and sleepers.

Eucalyptus platypus (round leaved moort, coastal moort)

A mallee of 3 - 5 m or more commonly a tree to 9 m tall. The crown is round, dense and often spreading (to 8 m). It occurs in rainfall areas averaging from 380 - 635 mm. It is frost hardy and tolerant of winds. It can withstand saline and poor drainage situations.

It is a good honey and pollen plant which flowers from June to January.

Eucalyptus polyanthemos (red box)

A medium sized tree to 25 m and diameter to 1 m. A native of Victoria and New South Wales, in the 500 - 800 mm rainfall range. It generally occurs on dry rocky or gravelly sites on rather poor soil.
Although the wood is hard, strong, tough and durable its uses are limited to fence posts because of its difficulty in seasoning.

Eucalyptus salmonophloia (salmon gum)

A medium - sized tree attaining a height of 30 m and diameter of 1 m, in ideal conditions. It occurs throughout the wheatbelt and eastern goldfields of Western Australia, with rainfalls ranging from 250 - 500 mm. The best specimens occur in rich red loam soils.

It occurs in open forest and woodland as companion to gimlet *(Eucalyptus salubris),* red morrel *(Eucalyptus longicornis),* silver topped gimlet *(Eucalyptus campaspe),* York gum *(Eucalyptus loxophleba),* redwood *(Eucalyptus transcontinentalis)* and raspberry jam *(Acacia acuminata).*

The wood is strong and durable with a very straight grain and was once used widely for mine timbers, both round and sawn, for second class railway sleepers and for firewood.

Eucalyptus salubris (gimlet)

A small to medium tree, occasionally reaching a height of 25 m and diameter of 0.6 m. It has a wide distribution in the Western Australian wheatbelt, in areas receiving rainfalls between 230 - 400 mm. It grows on a range of soils, but does best on good loamy soils, with a proportion of clay.

It grows in low woodland in association with salmon gum *(Eucalyptus salmonophloia),* redwood *(Eucalyptus transcontinentalis)*, mirret *(Eucalyptus celastroides),* square fruited mallee *(Eucalyptus pileata),* spinifex *(Triodia spp)* and bluebush *(Maireana spp)*

The wood is strong and dense and was used for poles, posts and firewood. The bark contains 18 - 20% tannin.

Eucalyptus sargentii (salt river gum)

A small tree (8 - 11 m tall with a short trunk) from the central wheatbelt region of Western Australia, rainfall 300 - 400 mm. It is very tolerant of drought, saline soils and wind.

It occurs in woodland in association with narrow leaved mallee *(Eucalyptus foecunda),* paperbarks *(Melaleuca spp)* and saltbushes *(Chenopodium spp).*

The wood is tough, dense and straight grained, but has never been common enough to be of commercial value.

Eucalyptus sideroxylon (red ironbark)

A medium sized woodland tree (to 25 m) which attains heights to 35 m and diameters of 1 m in forest situations. It is native to eastern Australian in the 450 - 1000 mm rainfall areas. It is not particular about soil type, but is usually found on hill slopes and the tops of hills.

The wood is very hard, very strong, extremely durable and very dense. It is used for railway sleepers and heavy construction.

Eucalyptus wandoo (wandoo, white gum)

A medium sized tree (to 30 m in height and 1 m in diameter), occurring in pockets through the south west of Western Australia. Annual rainfall varies from 400 - 700 mm and occurs mostly in the winter. This tree of the forest and open woodland is tolerant of a wide range of soils but prefers a sandy loam. Trials have shown wandoo to be more salt tolerant than salt river gum *(Eucalyptus sargentii).*

It occurs naturally as a companion to powder bark wandoo *(Eucalyptus accedens),* jarrah *(Eucalyptus marginata),* marri *(Eucalyptus calophylla)* and salmon gum *(Eucalyptus salmnophloia).*

The wood is very hard, very strong, tough, stiff and very durable and makes good railway sleepers, flooring and the poles are used for heavy construction. Poles of diameters of only 150 mm are suitable for light construction work.

BAMBOOS

Family: BAMBUSACEAE

Bambusa balcoa (balku)

A dense clumping bamboo from India. Attains heights of up to 22 m high with culm diameters of 15 cm. In north and eastern India it is considered the best bamboo for building purposes.

Bambusa longispiculata (mahal bamboo)

A vigorous Indian bamboo forming open clumps of up to 18m high, with culm diameters of 10 cm. Noted for its rather straight culms and long intervals between nodes which may reach 60 cm. The added feature of occasional white stripes on green culms make it an attractive ornamental. Suitable as a hedge.

Bambusa oldhamii (giant timber bamboo)

A compact, clumping bamboo noted for its useful erect culms which attain heights of 17 m and diameters of 10 cm. It is often planted as an ornamental windbreak or hedge around orchards. Tolerates temperatures of - 9°C. The buds are eaten in China.

***Bambusa ventricosa* (Buddha's belly bamboo)**

If grown under drought stressed conditions, this ornamental Chinese bamboo becomes a dwarf with swollen belly - shaped internodes, but if grown under normal conditions it may attain heights of up to 17 m with zigzag culms to 50 mm diameter.

***Dendrocalamus strictus* (male bamboo)**

Reported to be the most useful bamboo in India, where it is applied in general construction and provides the basis of a paper manufacturing industry. It forms dense clumps up to 18 m high with strong, (often solid) culms which may attain 12 cm in diameter. Once established, it will tolerate dry conditions, often shedding its leaves on a seasonal basis during drought stress. It is known to tolerate temperatures of -1°C. A source of edible manna for cooking. The young shoots and seeds are eaten. The dry bamboo is used for torches and the charcoal for smith's work. The leaves can be used as animal fodder as well as mats, baskets, masts, musical instruments, paper, poles, water pipes etc.

***Phyllostachys angusta* (stone bamboo)**

A runner bamboo, maximum stem diameter 30 mm, maximum height 7 m, and tolerant of temperatures as low as -7°C. It has an edible root and excellent technical properties for use in crafts and furniture.

***Phyllostachys aurea* (golden bamboo, golden fish pole bamboo)**

A dense runner that is reported not to be too invasive. A coastal plant that withstands some drought. Attains a stem diameter of 44 mm and a maximum height of 6 m at temperatures as low as -20.5°C. It has an edible shoot and as the name implies the stems are used for fish poles.

***Phyllostachys bambusoides* (Madake giant timber bamboo)**

One of the largest running bamboos in the world, attaining heights of 23 m and diameters of 15 cm. Originally from China, it is now considered the most useful bamboo in Japan, where its high quality wood is utilised for scaffolding and general construction. It is known to tolerate temperatures as low as -7°C. It also tolerates a wide range of acid and alkaline soils. Its new culm shoots are edible.

***Phyllostachys meyeri* (meyer bamboo)**

An invasive runner attaining a stem diameter of 50 mm and a height of 11 m. It is tolerant of temperatures as low as -8°C. The shoots are edible and the stems are reported to be strong, making it useful for building and construction work. A good hedge plant.

***Phyllostachys nigra* (black bamboo)**

A runner mostly grown for its culms which turn black with age. Although it usually only grows to a height of 2 m in the tropics, it may attain heights of up to 9 m and culm widths of 7.5 cm in more temperate regions and is hardy to -7°C. New culm shoots are edible when cooked.

***Phyllostachys nigra: henonsis* (henon bamboo)**

This graceful, hardy (to -21°C) giant bamboo is native to southern China and reaches heights of 17 m with culm diameters up to 7.5 cm. New culm shoots are edible if cooked. Considered the third most useful bamboo in Japan, the wood is very strong given its thin culm walls.

Phyllostachys rumbromarginata

An invasive runner with maximum stem diameter of 25 mm and growing to 10 m, in temperatures as low as -15°C. It has edible shoots and the stems are used for baskets, garden stakes and the manufacture of pan pipes.

Phyilostachys vivax

Similar to *P. bambusoides*. Rare runner bamboo. Uses include construction, artisanry, fuel.

Sasa palmata

A native of Japan, it is a small (2 - 4 m) runner bamboo, with leaves up to 35 cm long and 9 cm wide. It is useful both as a stock feed, shelter and as supply of paper pulp. It is highly invasive and will need to be controlled using stock to prevent it invading areas where it is not wanted.

FAST GROWING, TALL, PERENNIAL GRASSES, SUITABLE AS LOCKUP FODDER

***Cortaderia selloana* (pampas grass)**

A clumping, perennial grass to 3 m, which forms a fountain of cascading leaves. It is well suited to cool areas, yet thrives in heat, does well in both acid and alkaline soils, including waterlogged areas. A fast plant to recover from grazing. A good windbreak and shelter plant for stock. Good for checking soil erosion.

In New Zealand it is considered that one acre of pampas planted 1.8 m x 1.8 m is equivalent to having 3000 bales of hay in a shed. It is a drought reserve but also the deep roots bring up trace elements which seem to control grass tetany. Pampas may be invasive in some reforestation, although it reportedly grows as a companion to poplars.

It spreads by seed and by clumping. Propagating this grass is simply a matter of dividing a clump into many smaller clumps and planting these out.

***Pennisetum purpureum* (elephant grass)**

A clumping perennial to 4 m, native to tropical Africa, this grass is fairly tolerant of different soil conditions and remarkably drought tolerant for a plant of high rainfall areas. It spreads from stems arising from a creeping underground rhizome, from seed and cuttings. It is a plant very 'hungry' for nutrient but does not like waterlogged conditions. It is very fast to recover from browsing.

This is a very easy grass to propagate. Simply place small branches into damp soil either in situ, or in a nursery situation. Roots will strike very quickly.

***Pennisetum purpureum x americanum*(bana grass)**

A hybrid between elephant grass and pearl millet which produces little or no seed but grows well from cuttings and spreads by clumping. A broader leaf than elephant grass and not as aggressive. This is also a very easy grass to propagate. Simply lay whole stems (up to 4 m) into shallow trenches dug into damp soil either in situ, or in a nursery situation. Roots will strike very quickly and from each node along the stem, a new shoot will grow.

PALMS WITH UTILITY TO MAN

Family: ARECACEAE (PALMACEAE)

Most palms are fire tolerant, and are useful in bee forage systems.

***Acrocomia mexicana* (palmito de coyol)**

Leaf base is eaten raw, roasted, boiled and in pickles. The trunk is tapped and the sweet sap is made into a wine (vino de coyol). An oil extract similar to coconut oil is taken from the fruit.

***Acrocomia sclerocarpa* (macauba, mucaja, coco de catorro, gru gru nut)**

S. America: tropical dry savanna to tropical rainforest. Edible oil from kernel; fruit tastes like apricot; heart - of - palm vegetable crop often taken from thinnings; leaves for thatch; local products only; solitary feather palm. Semi - wild / wild.

***Acrocomia totai* (totaia, mbocaya palm)**

The refined seed kernel oil is an important source of cooking oil in Bolivia and Paraguay.

Aiphanes acanthophylla

Tall, spiny trunk and prickly foliage - effective fence barrier.

***Ancistrophyllum spp* (rattan)**

West Africa: used for furniture, baskets and other woven uses.

Ancistrophyllum acutiflorum

Cluster palm with many short spiny trunks - effective fence barrier.

***Areca catechu* (areca palm, betel palm)**

S. and SE Asia; inferred tropical rain forest, to 900 m; unknown wild. Seed as masticatory (850 kg/ha/yr); edible heart; young leaves for thatch; leaf sheaths for hats, containers; trunk for wood; seed in veterinary medicine; dye source. Cultivated alone or with annual or perennial crops. Seed propagation; cultivars based on seed quality. Yields at 6 years for 30 - 35 years. Limited research on selection and breeding; ornamental; solitary feather palm. Improved.

***Arenga pinnata* (sugar palm, gomuti palm)**

S. and SE Asia: inferred tropical rain forest into dry forest, to 1200 m; putatively wild, Assam and Burma. Sap for sugar, wine (36 l/tree/day); starch from trunk (75 kg/tree); fibre from leaf sheath; edible heart; juice of fruit corrosive but skin is edible; tall, spiny trunk and prickly foliage effective fence barrier. Widely cultivated India, SE Asia; sometimes planted after shifting cultivation; fibre exported; inedible fruit; monocarpic; monoecious; solitary terminal flowering feather palm; long spines on trunk. Unimproved.

Astrocaryum aculeatus

Spiny trunk and prickly foliage - effective fence barrier; seed has edible kernel.

***Astrocaryum jauari* (jauari, awarra)**

S. America: tropical rainforest sites subject to flooding. Edible oil, fruit, heart; heart - of - palm vegetable crop often taken from thinnings; leaves for thatch. Local products only; solitary feather palm. Semi - wild / wild.

***Astrocaryum murumuru* (murumuru)**

S. America: tropical rainforests sites subject to flooding. Edible oil; fruit for livestock; leaves for thatch. Local products only; solitary feather palm. Semi - wild / wild.

***Astrocaryum vulgare* (tucuma)**

S. America: tropical rainforest upland sites. Edible oil, fruit, heart; fibre from rachis; leaves for thatch. Local products only; solitary feather palm. Semi - wild / wild.

***Attalea funifera* (coquilla nut, piassava, piacava, Bahia piassava)**

S. America: tropical rainforest, coastal sites. Leaf base fibre; leaves for thatch; fruit eaten, promising oil seed palm. Fibre exported; monoecious; 15 - 20 m; solitary feather palm. Semi - wild / wild,

***Bactris gasipae*, syn. *Guilielma gasipaes* (peach paim, pejibaye)**

Central and S. America: inferred tropical rain forest, to 2000 m; prefers heavy soil and where rainfall is 2500 mm or less; unknown wild. High yielding palms; fruits high in protein and carbohydrate, (3.4 tonne dry fruit/ha/yr; one plant yields up to 12 kg of fruit; generally eaten boiled and dried; edible seed kernel, tasting somewhat like coconut; edible heart; heart - of - palm vegetable crop often taken from thinnings, multi - stemmed so do not need to sacrifice whole plant; trunk for wood; thorny stems effective fence barrier.

Nutritional composition of pejibaye per 100 grams of edible portion is: Water - 36.4 - 60.9%, Fat - 3.10 - 8.17 g, Protein - 0.340 - 0.633 g, Ash - 0.72 - 1.64 g, Calcium - 8.9 - 40.4 mg, Iron - 0.85 - 2.25 mg, Phosphorous - 33.5 - 55.2 mg, Carotene - 0.290 - 2.760 mg, Thiamin - 0.037 - 0.070 mg, Riboflavin - 0.099 - 0.154 mg, Niacin - 0.667 - 1.945 mg, Ascorbic acid - 14.8 - 41.4 mg

Widely cultivated in tropical America as forage for pigs and poultry. Propagation by seed or suckers; begins to bear fruit at 6 - 8 years and has an economic life of 75 years or more; at present there is a lack of superior cultivars for commercial plantations; fruit local product; hearts exported; multistemmed, usually spiny, suckering feather palm. Unimproved.

Bactris plumeria

Tall, spiny trunk and prickly foliage - effective fence barrier; edible fruit.

***Bejandia spp* (rattan)**

Indo - China: 1 species; used for furniture, baskets and other woven uses.

***Borassus aethiopium* (African fan palm)**

Africa: tropical wet savanna. Edible immature fruit; sap for wine; leaves for thatch, weaving. Local products only; solitary fan palm. Semi - wild / wild.

***Borassus aethiopican* (black rhum palm)**

Eastern Africa. Terminal bud is eaten raw or cooked. The fresh sap makes refreshing drinks and also is made into a palm wine. Seeds are germinated and eaten as a vegetable.

***Borassus flabellifer* (palmyra palm)**

S. Asia: tropical dry forest into savanna, to 750 m; naturalized in SE Asia and widely cultivated; tolerant of many locations and semi - hardy. Sap for sugar, wine (very high yields - 21 - 20 l/tree/day); nectar for honey; spathes for durable "paper" writing material; alcohol fuel (40,0001/acre) from nectar; tall, spiny trunk, toothed midrib and prickly foliage - effective fence barrier; fibre from leaf stalk; edible fruit; leaves for thatch, weaving; trunk for wood; many minor products. Frequently planted India; often grown with legume forage species; deep rooting in early stages, so site planting recommended; fibre exported; sugar, wine local products; solitary fan palm; dioecious. Unimproved.

***Butia capitata* (yatay or jelly palm)**

Very hardy palm, yielding to 40 degrees latitude in coastal areas; withstands temperatures down to - 5°C in rainfalls between 250 - 800 mm. Fruit edible with edible nut; oil extracted from kernels. Monoecious; seed coat needs scarification (by sanding or removal) to germinate; potential forage species for coastal SE Australia.

***Calamus spp* (rattan)**

Old World: tropical rain forest to 1000 m; rattan canes (to 6 t/ha); edible fruit some spp; fruit for medicinal use; roots of some rattans are pounded, washed and the starches roasted locally Cultivated small scale SE Asia; about 16 economic spp Malay peninsular; canes exported; climbing feather palm. Unimproved.

Calamus caesius, Calamus erinaceous, Calamus trachycoteus.

Malay, Borneo, Sabah: canes less than 25 mm but may cover many acres.

***Calamus manan, Calamus maximus, Calamus ornatus, Calamus scipionum* (malacca cane)**

Canes more than 25 mm; stick rattans, used for canes and chair legs etc.

***Calospatha spp* (rattan)**

Malay Peninsular: 1 species; used for furniture, baskets and other woven uses.

***Caryota mitis* (fishtail palm)**

SE Asia: tropical secondary forest. Starch from trunk (small amounts); edible heart, seed; leaf base fibre for stuffing and tinder. Local products only; solitary palm. Semi - wild / wild.

***Caryota urens* (fishtail palm, toddy palm)**

S. and SE Asia: tropical rain forest, esp. primary forest, to 1500 m. Extreme minimum temp - 3°C. Sap for wine, sugar (20 - 27 l/tree/day) - excellent quality; starch from trunk (100 - 150 kg/tree); fibre from leaf sheath; edible heart; fruit skin has stinging crystals. Casual cultivation, underdeveloped; fibre exported; wine, sugar, starch, local products; monocarpic; monoecious; solitary terminal flowering feather palm. Unimproved.

***Ceratonfobus spp* (rattan)**

Sumatra, Malay Peninsular: 6 species; used for furniture, baskets and other woven uses.

***Ceroxylon alpinum* (South American wax palm)**

S. America: tropical mountains; extreme minimum temperature - 3°C. Wax from trunk a substitute for carnauba wax; mountain reforestation; solitary feather palm. Semi - wild / wild.

***Cocos nucifera* (coconut palm)**

SE Asia: inferred tropical rain forest, esp. coastal sites, to 300 m, and 20 degrees latitude; ideal climate rainfall of 1000 mm or more, and mean average temperature of 22°C or more. Edible oil, fruit, drinks (2500 - 7500 nuts/ha/yr, copra yields to 1200 kg/ha/yr); edible heart; sugar from flower stalks; leaves for thatch, weaving; trunk for wood; many minor products. Monoecious. Most widely cultivated palm, alone or with annual or perennial crops; seed propagation but progress on vegetative propagation; breeding objectives to increase oil yield; numerous cultivars; starts producing nuts at 4 - 7 years; average yield is 75 nuts/year for 80 years, but normally replaced at 30 - 40 years; solitary feather palm. Improved.

***Copernicia prunifera, syn. Copernicia cerifera* (carnauba wax)**

S. America: tropical dry forest into savanna, esp. floodplains. Wax from leaves (100 g/tree/yr); leaves for weaving; trunks for wood, (very hard and durable). Incipient plantation cultivation; wax exported; woven goods. Hermaphrodite; local products; solitary fan palm. Unimproved.

***Copernicia spp* (yarey palms)**

Caribbean: tropical dry savanna. Fruit for livestock; leaves for weaving; trunks for pilings; compatible with grazing systems. Local products; fan palms. Semi - wild / wild.

Copernicia rigida

Spiky and bush - like - effective fence barrier.

***Corozo oleifera* (American oil palm)**

Central America: commercial oil yields for candles and industry. Trunk creeps along the ground.

***Corypha elata* (gewang palm)**

Indonesia: sap for sugar (only after flowering as palm is monocarpic); trunk for a coarse sago for livestock staple (pigs); leaves for thatch.

***Corypha umbraculifera, syn. Corypha talliera* (talipot palm)**

S. and SE Asia: inferred tropical rain forest, to 600 m; unknown wild. Sap for sugar, wine: starch from trunk (90 kg/tree); leaves for matting, paper. Widely cultivated; sugar, wine, starch local products; solitary terminal flowering fan palm. Unimproved.

Crysophia warscewiczii

Tall, spiny trunk and prickly foliage - effective fence barrier.

***Cyrtostachys lakka* (sealing wax palm).**

SE Asia: tropical peat swamp forests. Wood for pillars, flooring; swamp stabilisation. Common name misnomer, no wax produced; can be vegetatively propagated; outstanding ornamental; suckering feather palm. Semi - wild / wild.

***Daemonorops spp* (rattan)**

SE Asia: tropical rainforest. Rattan canes; some spp edible fruits; fruit scales yield "dragons blood"- former dye and Chinese medicine; furniture, baskets and other woven uses. Canes exported; about 5 economic spp Malay Peninsular; climbing, solitary or suckering feather palm. Semi - wild / wild.

***Diplothemium maritimum* (dune palm)**

Brazil: multistemmed, semi - hardy palm for dune stabilising; grows to 2 m. Edible green fruit. Fresh seed needed for germination.

***Elaeis guineensis* (oil palm, African oil palm)**

W. Africa: tropical rain forest, esp. open wet sites, to 800 m; semi - hardy to 16 degrees latitude, and 25 - 30 degrees on coasts; plantation near Cairns, Australia; semi - wild only. Edible oil (5 t/ha/yr) from fruit trusses, easily extracted by boiling and pressing; potential forage for pigs; sap for wine; edible heart; leaves for thatch, weaving; petioles for fence posts, construction. Monoecious; cultivated in pure stands on large estates; smallholders intercrop with annual crops; seed propagation, promising research on tissue culture; excellent improved cultivars; solitary feather palm. Improved. Palms first bear fruit after 2.5 years and can bear for 50 years but these palms would be very tall (over 20 m) and difficult to harvest.

***Elaeis oleifera* (American oil palm, corozo)**

Central and S. America: tropical rain forest lowlands. Edible and industrial oil. Limited cultivation in native area; excellent germplasm resource for hybrids with *Elaeis guineensis* to gain disease resistance; solitary feather palm. Unimproved.

***Eremospatha spp* (rattan)**

West Africa: used for furniture, baskets and other woven uses.

***Erythea edulis* (Guadaloupe palm)**

Caribbean and California; slightly frost hardy. Prolific bearer of fruit for human food and for forage. Young leaf buds are eaten as a vegetable. Hermaphrodite; grows to 10 m.

Eugeissona tristis

Cluster palm with spiny mid - rib - effective fence barrier.

***Eugeissona utilis* (bertam palm)**

SE Asia: tropical rain forest, esp. disturbed sites, to 1000 m. Starch from trunk; edible fruit; leaves for thatch. Rudimentary cultivation in Borneo; starch staple among some groups; suckering feather palm. Unimproved.

***Euterpe edulis* (palmito branco, jucara)**

S. America: tropical rainforest into subtropics, to 1000 m. Edible heart (1 kg/tree); heart - of - palm vegetable crop often taken from thinnings; cellulose. Limited cultivation; heart exported; solitary feather palm. Unimproved.

***Euterpe oleracea* (acai, palmito da Amazonia, assai palm)**

S. America: tropical rainforest sites subject to flooding. Edible heart (1 kg/tree); heart - of - palm vegetable crop often taken from thinnings; edible fruit used for beverages (assai), and forage for animals. Limited cultivation, heart exported; fruit local product; attractive ornamental; suckering feather palm. Unimproved.

Genonoma spp

Heart - of - palm vegetable crop often taken from thinnings.

***Guilielma gasipaes* (pejibaye, peach palm)**

See *Boctris gasipaes.*

Hyospathe spp

Heart - of - palm vegetable crop often taken from thinnings.

***Hyphaene thebiaca* (doum, dum palm, gingerbread palm)**

NE Africa: semi - desert, desert, to 600 m; hardy to 25 degrees latitude. Heavy crops of edible, hard - shelled fruit; edible heart; sap for wine; fruit for medicinal use, the fruit rind dried is made into molasses; unripe kernels are edible; leaves are used for weaving. Dioecious; cultivated since ancient times; local products only; promising desert palm. Deep rooting in early stages so requires deep pots or site planting; branched fan palm. Unimproved.

***Iriartea ventricosa* (palmeira, paxiuba, barriguda)**

Guiana - Brazil, Heart-of-palm vegetable crop often taken from thinnings. Flowers are burnt and the ash used as salt substitute.

***Iriartea setigera* (blowgun palm)**

Amazon: hunting blowguns from hollow stems.

***Jessenia bataua* (seje, patau palm)**

Northern South America: tropical rainforest, upland sites. Edible oil; fruit made into beverages; leaves for weaving; could be grown with Astrocaryum. Local products only; solitary feather palm. Semi - wild / wild.

***Jessenia polycarpa* (jagua palm)**

Amazon lowlands: fairly dry soils. Seed oil can be used for food, soaps and cosmetics. The milky residue from oil extraction is used as a beverage.

***Jubaea spectabilis, syn. Jubaea chilensis* (Chilean wine palm, coquitos, little coconut)**

Chile: temperate zone palm; cold hardy (to - 5°C and grows at 43 degrees lat. in France). Grows in rainfall 250 - 800 mm. Fruits with edible nut, useful for forage; trunks tapped for sap (400 l/year) to make sugar and wine. Monoecious; fresh seed needed; fast growing.

***Korthalsia spp* (rattan)**

31 species; used for furniture, baskets and other woven uses.

***Leopolinia piassaba* (piassaba, piacava, para piassaba)**

S. America: tropical rainforest, sites subject to flooding. Edible fruit; leaf base for fibre; leaves for thatch. Fibre exported; fruit local product; solitary feather palm. Semi - wild / wild.

***Licuala spp* (licuala)**

SE Asia, east to Vanuatu: tropical rainforest undergrowth. Edible heart; walking sticks from trunk; leaves for weaving and wrapping food. Local products only; ornamental; suckering fan palm. Semi - wild / wild.

***Linospadix monostachya* (walking stick palm)**

Australia: sub - tropical; edible fruit; potential forage species for livestock.

***Livistona spp* (serdang)**

SE Asia, east to Nggela: tropical rainforest, coastal and mountain sites. Edible fruit, heart; fruit for livestock; leaves for making fans; trunk for wood; local products only; Livistona saribus grows in poor soils; Livistona speciosa good ornamental; Livistona australis and Livistona decipiens grow right to the sea; solitary fan palms. Semi - wild / wild.

***Lodoicea maldivica* (coco de mer, double coconut)**

Praslin Island, Seychelles: rare and slow growing. Produces a twin coconut; which is the world's largest seed; very large leaves which can be used for roofing.

***Manicaria saccifera* (temiche palm, guagara, monkey cap palm)**

S. America: tropical rainforest, swampy sites. Edible fruit; starch from trunk (3 kg/tree); very large leaves for thatch, sails and which can be used for baskets, (60 - 90 cm deep), as they form natural sacs; spathe for cloth. Local products only; starch emergency food; solitary feather palm. Semi - wild / wild.

***Mauritia flexuosa, syn. Mauritia vinifera* (moriche, buriti, muriti, aguaje)**

S. America; tropical rainforest, sites subject to flooding. Staple food - edible oil, fruit, heart - of - palm; wine from fruit and sap; fruit high in vit. A and C; edible oil from kernel of fruit, similar in quality to more commonly used oils such as African oil palm kernels; fruit clusters reach 45 kg weight; sugar; starch from trunk (60 kg/tree); possible source of industrial starch; fruit has a pleasant, sweet, tangy taste; could be canned or candied; hearts - of - palm from shoots; leaf fibre for rope, sacking, nets and hammocks; petiole for cork; trunk for light, tough wood similar to balsa wood, for making rafts and floats. Local products only; indicator plant tropical rainforest swamp; solitary fan palm, to 25 m; spines on leaves. Semi - wild / wild.

Mauritia armata, Mauritia gracili

Fruits marketed in local areas.

***Maximiliana martiana* (inaja)**

S. America; tropical rainforest, dry, sandy, upland sites. Edible fruit, heart - of - palm, oil; leaves for thatch, weaving. Local products only; solitary feather palm. Semi - wild / wild.

***Metroxylon amicarum* (Caroline ivory nut palm)**

Caroline Island: non - hardy tropical palm. Produces ivory - like nut (vegetable ivory).

***Metroxylon sagu, Metroxylon laeve, Metroxylon rumphi* (sago palms)**

SE Asia: tropical rain forest swamps from S. Pacific Islands through Melanesia into Indonesia, Malaysia and Thailand. Sago from trunk (300 kg/tree); leaves for thatch. Cultivated and managed stands; starch exported; suckering, terminal flowering feather palm; lifespan 8 - 1 5 years, but usually felled before this. Unimproved.

***Myrialepis spp* (rattan)**

Sumatra, Malay Peninsular: 1 species; used for furniture, baskets and other woven uses.

***Nannorhops ritchieana* (mazani palm, Afghan palm)**

S. Asia: subtropical mountains to 1500 m. Edible fruit, heart - of - palm, young inflorescence; bears many seeds with edible pulp suited to forage; leaves for thatch, weaving; leaves, petioles, trunk for fuel; erosion control for mountain slopes; local products only; very hardy, shrub - like suckering fan palm. Semi - wild / wild.

***Nypa fruticans* (nipa palm)**

SE Asia: west to Sri Lanka, Bay of Bengal, including N. Australia: tropical rainforest, banks brackish water tidal rivers; in mangrove associations. Edible fruit, forage; sap for sugar (3000 kg sugar/hr/yr); leaves for thatch, weaving. Sometimes planted; local products only; trunkless, multistemmed, suckering feather palm; semi - hardy. Unimproved.

***Oenocarpus spp* (bacaba)**

S. America; tropical rainforest second growth, upland sites. Edible oil, fruit; trunk for wood; potential fibre source. Local products only; solitary feather palm. Semi - wild / wild.

***Oncocalamus spp* (rattan)**

West Africa: used for furniture, baskets and other woven uses.

***Oncosperma horridum* (bayas)**

SE Asia; tropical rainforest, inland to 500 - 1000 m only. Edible heart - of - palm; trunk for wood. Local products only; suckering feather palm. Semi - wild / wild.

***Oncosperma tigillarium* (nibong/nibung)**

SE Asia: tropical rainforest, coastal sites. Edible heart; trunk for wood, which is resistant to salt water. Local products only; suckering feather palm. Semi - wild / wild.

***Orbignya speciosa, syn. Altalia speciosa* (babacu or barbassu palm)**

S. America: tropical rainforest, upland sites. Staple palm; edible oil (40 kg/tree/yr), which can be used for the same purposes as coconut oil eg. margarine, shortening, toilet soap, fatty acids, detergents. The oil is obtained by conventional methods of oilseed extraction, and the remaining seedcake used for animal feed (75% protein); kernels contain 72% oil content, and smell and look like coconut meat. They may produce 1500 nuts/ha, or 1 tonne nuts /tree (90 kg of kernels); leaves for thatch; nuts have thick shells which are excellent fuel. Cultivated and managed stands; grows easily from fresh seed; grows to 20 m; oil exported; solitary feather palm. Unimproved.

***Orbignya cuatracasana* (tabaros palm)**

Edible seeds.

***Orbignya cohune* (cohune palm)**

Hardy to 30 degrees lat.

Orbignya martiana.

Humid forest.

Orbignya oleifera

Drier forests. See Orbygnia speciosa for uses of 0. martiana and 0. oieifera. All Orbygnia spp have potential as forage species for pigs, poultry, commercial oils.

***Parajubaea cocoides* (Quito palm, coquitos, little coconut)**

Native to the Andes, this tall (to 15 m), elegant palm occurs at very high altitudes (3,000 m and more) and is therefore especially suited to temperate and high altitude tropics. It is able to withstand temperatures well below 0°C and is also tolerant of high temperatures. It prefers a sunny position. The plant is reported to lose vigour when evening temperatures remain high. The plant has an appearance similar to the coconut palm.

It is long lived and extremely fast growing for a palm and can produce its first crop of nuts within 3 - 4 years. It puts down very deep roots and once established is able to survive for months without water.

The plant bears long clusters of 30 - 50 edible nuts, 4 - 5 cm in diameter, which look and taste like coconut. The nuts contain a usable oil. The nuts are green when they first fall and turn brown soon after.

Propagation is by seed. Germination can take a year or more. Fresh seed seems to germinate fastest. Leaving the seeds in a plastic bag of warm peat moss and checking them often has proven a good method of germination.

***Parajubaea torallyi* (janchicoco)**

Native to the ravines of sandstone mountains in central and southern Bolivia. This area sees no rain for 10 months of the year so the plant is very drought hardy. It is now considered to be an endangered species.

The nuts are edible, sweet and fleshy. They contain edible oil. The frond fibre is woven into rope, baskets, mats and saddles. The leaf midrib is used for fuel and the leaf stalk is used for is used for construction.

***Paurotis wrightii* (cluster swamp palm)**

S. Florida and the West Indies: swamps; duck forage. Multistemmed, semi - hardy; grows to 12 m.

***Phoenix canariensis* (Canary islands date)**

Canary Islands: hardy to 45 degrees lat; tolerant of sea winds; grows in Hobart, Tasmania; potential source of sugar for cooler regions.

Phoenix dactylifera (date palm)

Native to the tropical and sub tropical deserts of the Middle East: this palm has been cultivated for about 6,000 years. It is now not known in the wild. It is an erect palm growing to 36 m.

It requires full sun, and warm climates where the temperature rarely falls below - 6°C. It is hardy to 30 degrees latitude, but requires a sheltered site. Rainfall is typically 250 - 800 mm. The Arabs claim that it must have its feet in the water and its head in the fire of heaven. It usually grows on saline soils near brackish water. For date production, a rain free fruiting period is needed. Planting densities range from 100 - 500 per hectare depending on soil type and water availability. The plant does well in sand, loam and clay provided that drainage and aeration are good. It is tolerant of very alkaline soils and fairly high salt levels although the latter can affect growth and fruit production.

The fruit is borne on large clusters. Dates are eaten out of hand fresh and dried. They are used in cakes, biscuits, breads, pastes, syrups, jellies, ice cream and alcohol. In the Saharah desert they are fed to camels, horses and dogs. The terminal bud is eaten but this kills the palm. The seeds are dried and ground finely and mixed with flour to make bread. The seed is also soaked in water and fed to livestock and is a good chicken forage. Palms can be tapped (no more than two or three times) for sugar and wine production.

Nutritional composition of the dried date per 100 grams of edible portion is: Water - 22.5%, Energy - 274 calories, Carbohydrate - 72.9 g, Fat - 0.5 g, Protein - 2.2 g, Ash - 1.9 g, Calcium - 59 mg, Potassium - 648 mg, Sodium - 1 mg, Magnesium - 58 mg, Iron - 3.0 mg, Phosphorous - 63 mg, Chlorine - 390 mg, Sulphur - 120 mg, Iodine - 0.001 mg, Vitamin A - 50 I.U., Thiamin - 0.09 mg, Riboflavin - 0.10 mg, Niacin - 2.2 mg, Ascorbic acid - 2 mgs and the digestion time is 3.5 hours.

The seed is burned to make charcoal for silver smiths. The leaves are used to make thatch huts, mats, baskets, screens, packing crates and fans. The stripped fruit clusters are used as brooms. The trunks are used for posts and rafters in most constructions. All left over wood is used as firewood.

The fruit is used as a detersive and astringent for intestinal troubles. An infusion is used to treat sore throat, colds, bronchial catarrh. It is taken to relieve cystisis, gonorrhea, oedema, liver and abdominal troubles. It is mixed with beer to counter alcoholic intoxication. The gum which exudes from wounds in the trunk is used to treat genito - urinary ailments and diarrhoea. It is demulcent and diuretic. The roots are used for toothache.

Although date palms grow readily from seed, fruiting can take ten years and the fruit quality is variable. Also half of the raised seedlings are likely to be male. Where suckers of known plants are available, they are usually preferred. Suckers weigh about 45 kg when they are trans-planted. Where suckers are not available, large numbers of seedlings should be planted and suckers propagated from the best specimens. Males will be required for pollination.

Phoenix sylvestris (wild date palm, silver date palm)

India: tropical rainforest, to 1500 m. Wide range of soils and sites. Withstands light frosts. Edible fruit - wild life forage; sap for wine, sugar (40 kg sugar/tree/yr); leaves for weaving. Potential fuel or sugar crop for cooler areas of Australia. Limited cultivation; local products only; solitary feather palm. Unimproved.

Phoenix zeylandica (Ceylon date)

Ceylon: sweet edible fruit for forage; sugar when tapped.

Phytelephas macrocarpa (ivory nut palm, tagua)

S. America: tropical rainforest, esp. sites subject to flooding, to 2000 m. Edible immature fruit; former source vegetable ivory (can be carved). Local products only; solitary feather palm. Semi - wild / wild.

Pinanga spp (pinang)

SE Asia: tropical rainforest (very typical of virgin humid forest undergrowth), mountains to 1200 m; some spp in sites subject to flooding. Edible heart - of - palm; leaves for weaving; trunk for walking sticks and wood; erosion control. Local products only; forms thickets; small stature, suckering feather palm. Semi - wild / wild.

***Plectocomia spp* (rattan)**

SE Asia: 14 species; used for furniture, baskets and other woven uses.

***Plectocomiopsis spp* (rattan)**

SE Asia: 5 species; used for furniture , baskets and other woven uses.

***Pogonotium spp* (rattan)**

(New genus).

***Polyandrococos candescens* (orange - fruited palm)**

Brazil: large trusses of edible fruits. Monoecious; 4 - 6 m. Semi - wild/wild.

Prestoea spp

Heart - of - palm vegetable crop often taken from thinnings.

***Pritchardia spp* (lo'ulu palms, Fiji fan palm)**

Oceania: mainly Hawaiian Islands: grows dry, rocky, steep sites; deep soils, humid upland valleys. Leaves for thatch, hats, baskets, umbrellas, weaving; erosion control. Edible immature seed. Frost tender; grows easily from seed. Many species now rare or extinct. Local products only; solitary fan palms. Cultivated and semi - wild/wild.

Pritchardia gaudichaudi

Hawaii (Molokai); fruits eaten by deer, wild pigs, mongoose, cattle and man. Immature fruits (hawane) are valued as a delicacy in Hawaii.

Pritchardia brevicalyx, Pritchardia hillebrandii

Hawaii (Molokai). Cultivated for food.

***Pseudophoenix vinifera* (cherry palm)**

Haiti, Cuba. Hardy, slow growing; source of sugar.

***Raphia spp* (raffia palms, African piassava)**

W. Africa; tropical rainforest, swamps, sites subject to flooding Edible fruit, oil; sap for wines; leaves for fibre, thatch; petiole, leaf rachis building material. Fibre exported; fruit, oil wine local products; suckering, terminal flowering, feather palm. Semi - wild / wild.

***Raphia ruffia, syn, Raphia farinifera* (raffia palm)**

Madagascar: semi - hardy. Source of commercial raffia fibre. Monocarpic; propagates from suckers; large leaves.

***Raphia taedigara* (Panama raphia)**

Sugar extracted from flower stalks; raffia also a product.

***Raphia vinifera* (wine raffia palm, bamboo palm, Nigeria raphia)**

Sugary sap from flower stalks is made into a wine; raffia also a product.

***Retispatha spp* (rattan)**

(New genus).

***Roystonea elata* (royal palm, Florida royal palm, cabbage palm)**

SE North America: fruit for livestock; edible heart; heart - of - palm vegetable crop often taken from thinnings.

***Sabal palmetto* (cabbage palmetto, swamp palmetto)**

SE North America; tropical and subtropical, wet to dry. Edible fruit is very sweet and tastes like prunes. It is eaten raw, dried, made into syrup and bread. The terminal bud is a vegetable crop often taken from thinnings; leaves for thatch, weaving, brush fibre. The pith of the upper trunk is made into puddings, pies and eaten raw. Reforestation. Local products only; at least 25 spp; solitary fan palms. Semi - wild / wild.

***Salacca zalacca, syn. Salacca edulis* (salak palm)**

SE Asia: tropical rainforest, in dense shade, to 300 m. Edible fruit in hard scaly exterior; is said to be one of the finest palm fruits for eating raw. The seeds are edible. The leaves are used for thatch, mats; barrier and forage plant. Widely cultivated fruit, fresh or pickled; local products only; spiny, suckering feather palm to 5 m. Unimproved.

***Scheelea butyracea* (wine palm, palma real)**

Tropical South America. The trunk is tapped for sap to make a wine or toddy. Terminal buds and seed are eaten. The seed also yields an edible oil.

***Scheelea macrocarpa* (coroba)**

South America. Edible seed with an edible oil.

***Scheelea preussii* (corozo)**

Terminal bud and seed oil are edible.

***Serenoa repens* (saw palmetto)**

Native to south eastern North America. Edible fruit, seed and palm hearts.

Socratea spp

Heart - of - palm vegetable crop often taken from thinnings.

***Syagrus comosa* (jeriva, baba de boi)**

Brazil. Edible oil from nut.

***Syagrus coronata* (ouricuri palm, nicuri, licuri palm)**

Brazil; tropical dry forest to savanna. Pulp of fruit is edible; edible oil from seeds used to manufacture margarine; wax from leaves. Limited cultivation; oil, wax exported; wax substitute for carnauba wax; solitary feather palm. Stem pith is used to make a bread. Unimproved.

***Thrinax spp* (thatch palms)**

Caribbean: tropical and subtropical dry forest. Leaves for thatch, weaving; reforestation. Local products only; some spp grow on dry limestone sites; solitary fan palms. Semi - wild / wild.

***Thyrucarpus fortunei* (Chinese windmill palm)**

The young flower stem is eaten much like bamboo shoots. Flowers and terminal bud are also eaten.

***Washingtonia filifera* (California fan palm)**

The berry - like black fruits have a thin, sweet pulp with a similar taste to date. The fruit is eaten fresh, dried, or made into jellies. The terminal bud is roasted and eaten, the seeds are ground for making porridge and bread.

Welfia spp

Heart - of - palm vegetable crop often taken from thinnings.

Zalacca conferta,syn. Salacca conferta

Zombia spp

Cluster palm with many spiny trunks - effective fence barrier.

UTILITY LISTS

TREES AND SHRUBS WITH LOW FIRE POTENTIAL

Species	Common Name	(Generally recovers if known)
Acacia baileyana *	Cootamundra wattle	
Acacia cyanophylla	western wattle	
Acacia cyclops	coastal wattle	
Acacia glandulicarpa	hairy pod wattle	
Acacia howittii	sticky wattle	
Acacia ileaphylla	Gawler Range wattle	
Acacia melanoxylon *	blackwood	
Acacia pravissima	Ovens acacia	
Acacia prominens	golden rain wattle	
Acacia saligna	golden wreath wattle	
Acer campestre	common maple	
Acer ginnala		
Acer negundo	box elder maple	
Acer opalus	Italian maple	
Acer palmatum	Japanese maple	
Acer platanoides	Norway maple	
Acer pseudoplatanus	sycamore	yes
Aesculus hippocastenum	horse chestnut	
Agave spp	agaves	
Agonis juniperia	juniper myrtle	
Albizia lophantha	south west albizia	
Alnus cordata	Italian alder	
Alms glutinosa	common alder or black alder	
Alnus jorulensis	evergreen alder	
Alnus rubra	red alder	
Angopkora costata	gum myrtle	
Atriplex spp	saltbush	
Betula papyrifera	paperbark birch	
Betula pendula	silver birch	flaky bark fire prone
Betula szechuanica	Chinese birch	
Brachychiton populneus	kurrajong	
Calodedendrum capense	Cape chestnut	
Carya illinoensis	pecan	
Casuarina cunninghamiana	river sheoak	yes
Casuarina fraserana	Fraser's sheoak	
Casuarina glauca	swamp oak	yes
Casuarina obesa	salt sheoak	
Casuarina stricta	sheoak	yes
Casuarina torulosa	forest sheoak	
Caslanea dentata	American chestnut	
Castanea saliva	sweet chestnut	
Catalpa bignonioides	catalpa	
Catalpa speciosa	southern catalpa	
Celtis auslralis	nettle tree	
Celtis occidentalis	hackberry	
Ceratonia siliqua	carob	yes

TREES AND SHRUBS WITH LOW FIRE POTENTIAL Cont

Species	Common Name	(Generally recovers:- if known)
Cercis siliquastrum	Judas tree	
Chamaecytisus palmensis	tagasaste	no
Cinnamomum camphora	camphor laurel	
Gliricidia sepium	mother of cocoa	
Coprosma repens	New Zealand mirror plant	
Cornus capitata	evergreen dogwood	
Corynocarpus laevigatus	New Zealand laurel	
Crataegus monogyna	common hawthorn	
Crataegus phaenopyrum	Washington thorn	
Elaeagnus angustifolia	Russian olive	
Erythrina 'Indica'	coral tree	no
Eucalyptus maculata	spotted gum	
Eugenia smithii	lillipilli	
Exocarpos cupressiformis		yes
Fagus sylvatica	common beech	
Ficus macrophylla	Moreton Bay fig	
Fortunella japonica	round kumquat	yes
Fraxinus spp	ash	
Ginkgo biloba	ginkgo	
Grevillea robusta	silky oak	no
Griselinia littoralis	New Zealand broadleaf	
Hakea salicifolia	willow hakea	
Hakea sauveolens	sweet hakea	
Heterodendrum oblifolium	cattle bush	
Ilex aquifolium	holly	
Juglans hindsii	Californian black walnut	
Juglans nigra	black walnut	
Juglans regia	Persian walnut	
Lagunaria patersonia	pyramid tree	yes
Laurus nobilis	laurel	
Ligustrum spp	privet	
Liriodendron tulipifera	tulip tree	
Magnolia grandifolia	southern magnolia	
Melaleuca lanceolata	moonah	
Melia azedarach	white cedar, cape lilac	
Metrosideros excelsa	Christmas tree	
Myoporum insulare	boobialla	
Olea europaea	olive	yes
Opuntia spp	prickly pears	
Parrotia persica	parrotia	
Paulownia lomentosa	paulownia	
Photinia glabra	red leaf photinia	
Photinia serrulata	photinia, Chinese hawthorn	
Platanus acerifolia	London plane	
Platanus orientalis	oriental plane	
Pistacia chinensis	Chinese pistachio	
Pittosporum eugenioides	tarata	
Pittosporum phillyreoides	weeping pittosporum, native apricot, Wiluna willow	
Pittosporum undulatum	sweet pittosporum	
Populus alba	white poplar	yes

Populus deltoides	cottonwood	
Populus euphratica	Euphrates poplar	
Populus nigra	black poplar	yes
Populus simonii	Simons poplar	
Populus yunnanensis	Chinese poplar	
Prunus spp (most)	plum, cherry, apricot, almond, etc.	yes
Quercus acutissima	Japanese sawtooth oak	
Quercus canadensis	Algerian oak	
Quercus cerris	Turkey oak	
Quercus douglasii	blue oak	
Quercus ilex	holm oak	
Quercus lobata	valley oak	
Quercus lusilanica	Portugese oak	
Quercus macrocarpa	burr oak	
Quercus palustris	pin oak	
Quercus phellos	willow oak	
Quercus robur	English oak	yes
Quercus suber	cork oak	
Quercus virginiana	live oak	
Robinia pseudoacacia	black locust	
Salix spp	willows	
Sapium sebiferum	Chinese tallow tree	
Schinus mode	peppercorn tree	yes
Sophora japonica	pagoda tree	
Sorbus aucuparia	rowan	
Sorbus domestica	service tree	
Tamarix aphylla	athel tamarisk	
Taxodium distichum	swamp cyprus	
Tilia vulgaris	linden	
Toona australis	red cedar	
Tristania spp	brush box	
Ulmus spp	elm	
Zelkova serrata	zelkova	

NOTE * denotes conflicting reports of trees ability to burn.

GROUND COVER WITH LOW FIRE POTENTIAL

Achillea lomentosa	woolly yarrow
Ajuga spp	bugle lily
Arcotheca calendulaceum	capeweed
Atriplex spp	
Baccaris pilularis	dwarf coyote bush
Carpobrotus spp	pigface
Cistus landanifer	gum rockrose
Coprosma kirkii	
Debsperma 'alba'	pigface
Drosanthemum hispidum	
Eriodictyon trichocalyx	yerba santa
Gazania spp	
Helianthemum spp	sunrose
Hedera spp	ivy (self clinging varieties)
Helianthemum mmmularium	sunrose
Helianthus annua	sunflower
Jacksonia spp	
Jalenia pubescens	
Kennedia spp	running postman
Kochia spp	
Lampronthus spp	
Lotus birtholetii	parrot beak
Mesembryanthemum spp	small leaved ice plant
Myoporum spp	
Pelargonium spp	
Portulaca spp	
Rhagodia spp	saltbush
Rosmarinus officinalis prostratus	prostrate rosemary
Santolina spp	
Sedum spp	
Verbena peruviana	verbena
Vinca spp	periwinkle

MEDICINAL HERBS FOR LIVESTOCK

The following plants can be incorporated into animal forage and fodder systems, to allow animals to access their own medicines. Animals will browse the herbs as they need them. Not all of the herbs will suit all areas, but as broad a spectrum as possible should be made available to livestock at all times:

> anise, asparagus, beet, balm, borage, chicory, comfrey, cress, daisy, dandelion, dill, dock, fennel, fenugreek, flax, foxglove, garlic, herb Robert, hollyhock, kale, lavender, lucerne, mallow, marjoram, mint, nettle, parsley, plantain, rosemary, rue, sage, southernwood, sorrel, tansy, thistle, thyme, valerian, verusin, violet.

The trees known to have medicinal qualities include:

> alder, ash, beech, birch, elder, elm, hawthorn, hazel, holly, juniper, lemon, lime, quince, raspberry, senna, walnut (leaves good butter milk feed), witchhazel.

BEE FORAGE SYSTEM

Commercial apiarists in Australia will transport their hives up to 1000 km to follow the honey flow. The expense is enormous, the hidden cost prohibitive. Essentially, fossil fuel is being converted to honey with very poor efficiency. Alternatively, a year round honey flow can be established for permanent hive sites.

The bee forage system should be integrated within a whole property design and where possible nectar (N) and pollen (P) producing plants are used in preference to other utility plants having no benefit to the bees. Bees can effectively travel 2 miles from the hive. The bee forage system should complement existing vegetation and may include the following:

Note flowering times can vary in various climates and with different years.

Hedgerow (Bee Forage)

The hedgerow system not only provides food for bees but also offers wind - free flight paths so that they can convert nectar to honey at a greater efficiency. A particular emphasis should be placed on the following species in hedgerows because of their combined bee forage, medicinal (to livestock) and fire - retardant properties:

Plant	Nectar	Pollen	Season/Notes
alder	N	P	
ash	N		
basswood			early summer
citrus	N	P	
elm	N	P	
Grevilka robusta			spring summer
Hakea salicifolia			spring
hawthorn	N		spring - pleach for fences
linden			
maple	N	P	including box elder maple
poplars	N	P	depending on sex of tree
tagasaste	N	P	most winter through spring; staggered cutting increases flowering duration

Understorey Hedgerow (Bee Forage)

Plant	Nectar	Pollen	Season/Notes
balm			
borage			long season
capeweed	N	P	early spring
chicory	N	P	
daisy			
dandelion	N	P	long season
fennel			long season
lavender			all year with different varieties
marjoram			
mint	N		
raspberry	N	P	spring, summer
rosemary			
sage	N	P	
thisdes	N	P	milk thistle and globe artichoke
thyme	N	P	
violets			

Animal Forage System (Bee Forage)

Plant	Nectar	Pollen	Season/Notes
Acacia spp		P	
black locust	N	P	1600 kg/ha N yield estimated in Rumania. Spring, summer
carob	N	P	pods can be fed to bees to help them winter
honey locust	N	P	spring
oak		P	
poplars	N	P	depends on sex of tree
tagasaste	N	P	most of winter through spring.
(The progressive feeding of tagasaste to stock in rotation will provide the maximum flowering period of the tagasaste)			
willows	N	P	depends on sex of tree

Plants to Add to Pasture (Bee Forage)

The following plants can be introduced to pasture to increase honey production. Where possible introduce a whole range of plants so as to extend the flowering season :

Plant	Nectar	Pollen	Season/Notes
clovers	N	P	up to 400 kg/ha N yield estimated in Russia; crimson clover is particularly high.
cowpea	N	P	
lotus spp	N	P	
lucerne	N	P	very long flowering period, 78 - 285 kg/ha/day measured in the USA; good lock-up fodder
lupins	N	P	

Remnant Forest and Woodlot Trees (Bee Forage)

The remnant forest is supplemented by many multipurpose species, with an emphasis on those plants which produce out of season with the natives. The following could be used:

Plant	Nectar	Pollen	Season/Notes
Acacia spp		P	valuable source of pollen over winter/spring
Banksia amula			winter
Banksia ericifolia			winter through to summer
Banksia grandis			spring
Banksia integrifolia			autumn, winter, spring
Banksia serrata			summer
Banksia spinulosa			autumn, winter, spring
Dryandra spp	N		autumn, winter
Eucalyptus albens (white box)	N	P	autumn
Eucalyptus calophylla (marri)	N		summer, autumn
Eucalyptus camaldulensis (river red gum)	N	P	spring, summer
Eucalyptus cladocalyx (sugar gum)			summer, autumn
Eucalyptus cornuta (yate)	N	P	spring, summer
Eucalyptus cosmophylla (cup gum)			autumn, winter
Eucalyptus diversicolor (karri)	N		spring, summer, even winter some years,
Eucalyptus diversifolia (soap mallee)			summer
Eucalyptus dumosa (white mallee)			summer, autumn
Eucalyptus eremophila (tall sand mallee)	N	P	abundant in winter, spring, even summer
Eucalyptus ficifolia (scarlet flowering gum)			summer
Eucalyptus globulus (blue gum)	N	P	winter, spring, summer
Eucalyptus gomphocephala (tuart)	N		summer, autumn
Eucalyptus grandis (rose gum)	N	P	winter, spring
Eucalyptus grossa (Phillip's river gum)			spring, summer
Eucalyptus gummifera (red bloodwood)			spring, summer, autumn
Eucalyptus incrassata (ridge - fruited mallee)			autumn
Eucalyptus largiflorens (black box)	N	P	winter, spring, summer
Eucalyptus lehmannii (bushy yate)			autumn, winter, spring
Eucalyptus macrandra (long flowered marlock)	N	P	summer, autumn
Eucalyptus macrorhyncha (red stringybark)			summer, autumn
Eucalyptus maculata (spotted gum)	N	P	a major source winter / spring nectar
Eucalyptus marginala (jarrah)	N		spring, summer
Eucalyptus melliodora (yellow box)	N		considered the best honey of all

			eucalypts; spring, summer
Eucalyptus microcarpa (grey box)	N	P	good honey; summer, autumn, winter
Eucalyptus muellerana (yellow stringybark)			spring, summer, autumn
Eucalyptus obliqua (messmate)			summer, autumn
Eucalyptus occidentalis (swamp yate)	N		autumn
Eucalyptus ovata (swamp gum)			autumn, winter
Eucalyptus patens (yarri)	N	P	spring, summer
Eucalyptus pauciflora (snow gum)			spring, summer
Eucalyptus platypus (moort)	N	P	good bee plant; winter, spring, summer
Eucalyptus polyanthemos (blue mallee)	N		winter, spring, summer
Eucalyptus polyanthemos (red box)	N	P	spring, summer
Eucalyptus salmonophloia (salmon gum)	N		choice honey; summer, autumn
Eucalyptus salubris (gimlet)	N	P	light amber honey, spring, summer, autumn
Eucalyptus stellulata (black Sally)			flowers most of the year
Eucalyptus viminalis (manna gum)			spring, summer, autumn
Eucalyptus wandoo (wandoo)	N	P	spring, summer, autumn
Eucryphia lucida (leatherwood)	N		extended nectar flow
Grevillea spp.			
Hakea eriantha	N		spring
Hakea rancisiana	N		winter, spring
Hakea spp	N		wildflower potential oil production

Others Bee Forage Plants

Plant	Nectar	Pollen	Season/Notes
blueberries	N		
Buddkia spp			
cape lilac			
castor			
Chilean nut (*Gevuina avellana*)			
Chinese tallow tree			
citrus	N	P	high producers of honey
grey mangrove	N		autumn, winter; good light honey
ivy			
Japanese raisin tree			
marsh marigold			
palms			
pride of Madeira			masses of winter flowers
Prunus spp	N	P	spring
tupelo			

COMPANION PLANTS

This list is only a starting point. Many species have natural companions listed in the text, others are still unknown.

FRUIT AND NUTTREES

almond	tagasaste, lucerne
apricot	as above, also plant inter - swales or inter - rows to *Acacia saligna* and avoid interplanting with vegetable crops. Also basil, tansy, southernwood,
apple	tagasaste, lucerne, wallflowers, chives, nasturtiums, garlic, mulberry (avoid walnut)
avocado	tagasaste, *Acacia pulchella,* garlic
Chinese chestnut	*Acacia pulchella, A. suaveolens, Albizia lophantha*, garlic
carob	tagasaste, *Albizia lopkantha*, garlic
capulin cherry	*Acacia spp,* tagasaste, garlic
cherry	tagasaste, garlic
citrus	lucerne, tagasaste, raspberries, guava, garlic
feijoa	as above
fig	tagasaste, lucerne, garlic
guava	as above, citrus, garlic
grapes	geraniums, mulberry, hyssop, basil, peas, beans, garlic,
jujube	tagasaste, lucerne, garlic
loquat	*Albizia lophantha*, garlic
lichee	tagasaste, lucerne, garlic
macadamia	*Acacia pulchella*, tagasaste, garlic
mango	as above
mulberry	*Albizia lophantha*, tagasaste, lucerne, garlic
olive	as above
persimmon	as above
plum or prune	*Acacia spp,* garlic, tagasaste
peach or nectarine	tagasaste, lucerne, garlic, tansy
quince	as above
white sapote	as above, *Acacia spp*
walnut	*Albizia lophantha,* tagasaste, garlic, lucerne, mulberry (not a good companion to most species)

VEGETABLES AND HERBS (Good companions)

asparagus	tomatoes, parsley, basil
basil	tomatoes, asparagus, parsley, apricots
beans	carrots, cucumbers, cabbages, lettuce, peas, parsley, cauliflower, spinach
beans, dwarf	beetroot, potatoes
beetroot	onions, silverbeet, kohlrabi, lettuce, cabbage, dwarf beans
borage	strawberries
cabbages	beans, beetroot, celery, mint, thyme, sage, rosemary, dill, potatoes, chamomile, oregano, hyssop
carrots	peas, radishes, lettuce, chives, sage, onions, leeks
cauliflowers	celery, bean
celery	tomatoes, dill, beans, leeks, cabbage, cauliflower
chervil	dill, coriander
chives	parsley, carrots
coriander	dill, chervil, cabbages, carrots
cucumbers	potatoes, beans, celery, lettuce, sweetcorn, savoy cabbages, sunflowers, radishes

dill	carrots, tomatoes
horseradish	potatoes
kohlrabi	beetroot, onions
garlic	roses, apples, peaches
leeks	carrots, celery
lettuce	carrots, onions, strawberries, beetroot, cabbages, radishes, marigolds
marigold	lettuce, potatoes, tomatoes, roses, beans
mint	cabbages
nasturtiums	apples, cabbages, cauliflowers, broccoli, Brussels sprouts, kohlrabi, turnips, radishes, cucumbers, zucchini
onions	carrots, silver beet, beetroot, lettuce
parsnips	peas, potatoes, peppers, beans, radishes, garlic
peas	potatoes, radishes, carrots, turnips
potatoes	peas, beans, cabbages, sweetcorn, broad beans, nasturtiums, marigolds
pumpkin	sweetcorn
radishes	lettuce, peas, chervil, nasturtiums
sage	carrots, cabbages
silverbeet	onions, beetroot, lavender
spinach	strawberries
strawberries	borage, lettuce, spinach, sage
sunflowers	squash, cucumber
sweetcorn	broad beans, potatoes, melons, tomatoes, cucumber, squash
thyme	cabbage family
tomatoes	asparagus, celery, parsley, basil, carrots, chives, marigolds
turnips	peas
zucchini	nasturtiums

VEGETABLES AND HERBS (Bad companions)

beans	onions, garlic, fennel, gladioli, sunflowers
broccoli	strawberries
cabbages	rue
carrots	tomatoes
cauliflowers	strawberries
coriander	fennel
fennel	beans, tomatoes, kohlrabi, coriander, wormwood
garlic	peas, beans, cabbages, strawberries
hyssop	radishes
kohlrabi	tomatoes, beans
mint	parsley
parsnip	carrots, celery, cabbages
peas	onions, shallots, garlic
potatoes	apples, cherries, cucumbers, pumpkins, sunflowers, tomatoes, raspberries, rosemary
pumpkin	potatoes
radishes	hyssop
raspberries	potatoes
strawberries	cabbages, cauliflowers, Brussels sprouts, gladioli, tomatoes
sunflowers	potatoes
tomatoes	rosemary, potatoes, kohlrabi, fennel, apricots

WATER PLANTS

Water plants can provide direct food to humans and to fish and other aquatic animals and also oxygenate water. No aquatic system is complete without a range of plants. The plants of water systems can be classed into four broad and not always clearly defined groups:

Submerged Plants. These plants are valuable in fish production. The only part of these plants that may rise above the water is the flowers. The roots (if any) act only as anchors. Transfer of nutrients, carbon dioxide and oxygen takes place over the entire surface of the plant. Oxygen released during photosynthesis is given off direcdy to the water which increases water oxygen levels to the benefit of fish and those bacteria which require oxygen and break down organic matter.

Floating - Leaved Plants. Often directly useful to humans but of less direct benefit to fish, these plants are usually only found in calm waters. Some anchor themselves to the bottom and absorb nutrient from the soil while others float on the surface and derive nutrient from the water. Their leaves often shade the entire water surface reducing the amount of light, heat and oxygen actually reaching the water.

Emergent Plants. These plants live at the waters edge where their roots and stems live below water, but their leaves and flowers rise above water. By arranging shallows in ponds large areas can be dedicated to emergent plants.

Margin Plants. These plants do not actually grow in the water, although their roots may be submerged for a portion of the year. They grow in association with the water system and derive extra moisture from the moist soils of the edge.

UTILITY SUBMERGED PLANTS

Plankton, including algae, bacteria, flagellates and diatoms

A reasonable balance of these organisms can usually be gained by simply introducing water from an established aquatic system such as a lake, creek or large pond.

UTILITY FLOATING - LEAVED PLANTS

Azolla spp

Family: AZOLLACEAE

A small, perennial, free - floating fern which hosts a microscopic alga, *Anabaena azolla*, in its leaves. The alga fixes nitrogen from the atmosphere and makes it available to the *Azolla* in the form of ammonia. Laboratory research has found that the alga can also be made to produce hydrogen from water, which shows much promise as a method of harnessing and storing solar energy cheaply. *Azolla pinnata* is used extensively in Vietnam as a companion in rice paddies because of the nitrogen that it makes available to the rice plants. It also feeds the tilapia and other fish in a rice paddy system. It is a valuable food for pigs, poultry and waterfowl and has been reported to be valuable for controlling mosquitoes and weeds by covering the water surface. It is also a good nitrogen - rich mulch material, which once dried, has similar water holding properties to peat moss.

Wolffia spp, Wolffiella spp, Spirodella spp, Lemna spp (duckweed)

Family: LEMNACEAE

The 40 or so known, perennial, free - floating species of duckweed are among the most vigorously growing of plants on the planet, some doubling their numbers every three days. They are valuable plants for removing excess nutrient from water. Tests on *Lemna minor* and *Lemna trisulca* have shown that they can concentrate boron, aluminium, manganese, iron, titanium, copper and cobalt into their tissue from water. They are good fodder for some fish, ducks and domestic animals. It has also been used as human food.

***Wolffia arrhiza* (khai - nam, mijinko - uki - kusa)**

The smallest flowering plant on the planet and is edible to humans. On a dry weight basis it contains 20% protein, 44% carbohydrate and 5% fat, vitamins. A, B2, B6 and G. It is cultivated in Burma, Laos and Thailand as a vegetable, tasting somewhat like sweet cabbage. In Thailand, the calculated annual yield is 265 tons wet weight or 10.5 tons dry weight/ha/year.

It is an ideal animal feed for water fowl and other poultry, catde and pigs.

Spirodella oligorhiza, Spirodella polyrhiza

These species have the potential to produce the equivalent feed value of 60 ha of soybeans in 1 ha. (Protein 37 - 45%, nitrogen 6 - 7%, phosphorous 1.4 - 3%, potassium 1.5 - 3%, calcium 1%, ash 8 - 14%, fibre 7 - 10%, fat 4 - 6%, metabolisable energy 1958 calories/kg.

Neptunia oleracea (neptunia, water mimosa, rau nhut, pak kachet)

Family: MIMOSACEAE

This floating, leguminous plant is native to Asia, Africa and tropical America, where it can be found growing on still or slow moving fresh water. In Thailand and Vietnam it is grown in tanks. The leaves and stems are eaten in salads and the seed pods are cooked and eaten. The plants are also cooked as greens.

Trapa spp (Indian water chestnut, water caltrop, Jesuit nut, ling - chio)

Family: TRAPACEAE

This perennial, floating, attached, native to Europe, India and eastern Asia grows in water depths from 0.3 - 1 m. There are some 9 species which range from tropical to temperate. The kernels of the spiny fruit are eaten. It has become a pestilent weed in the USA and is a prohibited import into Australia, although it already occurs in some parts of Australia,

Nympha alba, Nympha gigantea, Nympha odorata, Nympha tellata (water lilies)

Family: NYMPHAEACEAE

These plants take root in the mud and the leaves float on the water (depths up to 1.5 m). The roots are edible and in Europe, *Nympha alba* is used as a feed for pigs.

UTILITY EMERGENT PLANTS

Ceratopteris thalictroides

Family: PARKERIACEAE

An aquatic fern growing wild along ditches, in swamps and paddy fields of the tropics and semi - tropics. The fiddleheads are eaten raw and cooked. The entire plant, except the root may be cooked and eaten as greens.

Colocasia esculenta, syn. Colocasia antiquorum (taro, coco - yam)

Family: ARACEAE

Taro is possibly the earliest grown plant and is usually grown in paddy culture like rice or on dry land under irrigation. There must be a 6 - 7 month frost - free period for successful cropping. Both corm and cormel of the plant are eaten by humans. The roots are comparable in nutrition to those of potatoes and sweet potatoes and the leaves and petioles can be cooked and eaten like spinach. The plant must be cooked.

Nutritional composition of taro **leaves and stems** per 100 grams of edible portion is: Water - 87.2%, Energy - 40 calories, Carbohydrate - 7.4 g, Fat - 0.8 g, Protein - 3.0 g, Ash - 1.6g, Calcium - 76 mg, Iron - 1.0 mg, Ascorbic acid - 31 mg.

Nutritional composition of taro **corms and tubers** per 100 grams of edible portion is: Water - 73%, Energy- 98 calories, Carbohydrate - 23.7 g, Fat - 0.2 g, Protein - 1.9 g, Ash - 1.2 g, Calcium - 28 mg, Potassium - 514 mg, Sodium - 7 mg, Iron - 1.0 mg, Phosphorous - 61 mg, Vitamin A - 20 I.U, Thiamin - 0.13 mg, Riboflavin - 0.04 mg, Niacin - 1.1 mg, Ascorbic acid - 4 mg.

Some cultivars are highly salt tolerant. The small tubers and the crown of the main tuber are used for propagation.

Eleocharis dulcis, syn. Eleocharis tuberosa (Chinese water chestnut)

Family: CYPERACEAE

This perennial, rush - like plant with emergent, cylindrical, narrow, spike leaves is native to N. Australia, Malaysia, SE Asia, Madagascar, Fiji and New Caledonia. It grows in 50 - 200 mm of water and is usually grown in flooded fields, often in rotation with rice. Yields of the rhizome, which is said to be as nutritious as the potato (carbohydrate 30%, protein 1.5%) can exceed 7 tons per ha. It can also be grazed by stock. It grows as companion to taro, lotus and water lilies.

Glyceria fluitans (floating manna grass)

Family: POACEAE

A perennial grass to 120 cm, usually found in stagnant or slow moving water. It has a creeping rhizome and the weak stems and leaves bend to float on the water. It is not prone to forming dense stands and is a useful plant because insect larvae and other small animals shelter in the leaves, which lie loosely on the water. The seed has been used for human food.

Glyceria maxima, syn. Glyceria aquatica (great water grass)

A dense, clumping, perennial grass which grows up to 2 m and spreads by creeping rhizomes. The leaves are a good fish food and the seed has been used for human food. The seed flour can be made into a good quality bread, used for thickening soups and stews and for making puddings.

Ipomea aquatica (kang kong, water spinach, engsai, ong choy)

Family: CONVOLVULACEAE

A native of southern China, India, south east Asia and Taiwan, this tropical trailing herb is found in muddy streams, freshwater ponds and marshes. The seed is usually germinated and grown on land until about six weeks when the plant can be flooded. Annual yields of up to 90,000 kg/ha have been recorded. Protein varies from 1.9 - 4.6% in the fresh plant and carbohydrate averages 4.3%. The leaves are a good source of vitamins A, C, and E, iron and other minerals. It is a good source of animal feed which does not require dewatering and also a valued food for herbivorous fish. The fresh young leaves and shoots are boiled or cooked in oil and eaten as a vegetable. Young tips are selected for salads. The young stems are used in pickles. With yields of up to 60 t/ha this is one of the most productive leaf vegetables known. It is cold sensitive and is usually grown as an annual in cooler climates.

Limnocharis flava (yellow veivetleaf, berek)

Family: LIMNOCHARITACEAE

Native to Mexico, West Indies, Peru and Brazil, it is cultivated in the rice paddies of Malaysia and marketed as a fresh vegetable. Old plants are ploughed into the rice fields as green manure and the plant is readily eaten by cattle (leaf protein 1 - 1.6%).

Nasturtium officinal, syn. Rorippa nasturtium - aquatica (water cress)

Family: BRASSICACEAE (CRUCIFEREAE)

Native to Europe and northern Asia, this fast growing (30 - 60 days), emergent, broad - leafed herb of the mustard family requires cool or cold flowing water. It grows submerged, floating or spread over mud surfaces. It is usually grown in beds covered with 10 cm of water.

Nutritional composition of water cress per 100 grams of edible portion is: Water - 93.3%, Energy - 19 calories, Carbohydrate - 3 g, Fat - 0.3 g, Protein - 2.2 g, Ash - 1.2g, Calcium - 151 mg, Potassium - 282 mg, Sodium - 52 mg, Magnesium - 20 mg, Iron - 1.7 mg, Phosphorous - 54 mg, Chlorine - 775 mg, Sulphur - 5390 mg, Vitamin A - 4900 I.U, Thiamin - 0.08 mg, Riboflavin - 0.16 mg, Niacin - 0.9 mg, Ascorbic acid - 79 mg and the digestion time is 3.25 hours.

Water cress should not be grown for human consumption in polluted waters. Leaves and shoots are eaten fresh in salads and sandwiches, cooked in soups and stews. The seeds can be made into a mustard or sprouted as a salad green. It has many medicinal properties, but Lust, JB "The Herb Book" (1980) warns "Excessive or prolonged use can lead to kidney problems. It should not be taken daily and no longer than four weeks even with interruptions."

Nelumbo nucifera (lotus, Chinese lotus, sacred lotus)

Family: NELUMBONACEAE

A herbaceous perennial growing to 2 m tall, the lotus is cultivated for the seed, leaves (harvested in spring) and the roots (rhizomes), which are harvested in the autumn. The leaves can grow up to 1 m in diameter. It is native to the north of Australia but some varieties are suited to more temperate sites.

Oryia sativa (floating rice)

Family: POACEAE

This species floats on water up to 6 m deep, although the seed is usually broadcast onto dry or damp soil before flooding occurs. The plants will withstand being flooded for up to 30 days.

Phragmites spp (trinius)

Family: POACEAE (GRAMINEAE)

Found growing in water depths to 1.5 metres, this perennial, emergent, narrow - leaf grass grows to heights of up to 4 m. It is a good habitat for fish and wildlife although unchecked it can become invasive. Its uses include thatching and building, reed mats and fodder.

Phragmites australis, syn. Phragmites communis **(common reed grass, wild broomcorn)**

A cosmopolitan plant which is common in Australia where it is usually found growing in dense clumps at the margins of swamps, lakes and water courses. It is tolerant of brackish water. This tall (2 - 3 m) grass has edible shoots which are eaten like bamboo sprouts or pickled. They have to be harvested young, preferably before they turn green, and are said to taste like asparagus. Native North Americans made a marshmallow - like confection from the dried stems, and also ate the rhizome boiled or roasted like potatoes. Dried young leaves are mixed with cereal flour to make dumplings in Japan. The plant has been used for making bags and baskets, matting, sandals, thatching, arrows, spears, paper and musical reeds. A sugary gum which exudes from the stem can be rolled into balls and eaten as a sweet. The grain is difficult to remove from its hull but is claimed to be nutritious.

Sagittaria latifolia, Sagittaria fascicuiata **(arrow - head or duck potatoes)**

Family: ALISMATACEAE

This plant occurs at the water's edge, and to a depth of 0.5 m. The tubers were eaten by the American Indians (who called them wapatoo) and are said to be as good as potatoes.

Sagittaria sagittifolia **(arrow - head)**

This native of Europe grows to about 1.5 m and may spread extensively throughout ponds. The walnut - sized roots are the plant's means of over - wintering, and are edible. They should be harvested in autumn. It is considered a good water fowl plant.

Sagittaria trifoiia, syn. Sagittaria sinensis **(arrowhead)**

A native to tropical and sub - tropical Asia this plant produces eight or more underground stems, each with a corm on the end. These corms are boiled and eaten like potatoes and are high in protein (5 - 7%) for a root crop. It requires a 6 - 7 month growing season.

Typha spp **(cumbungi, cattail, butlrush)**

Family: TYPHACEAE

These narrow, linear - leafed plants occur throughout the world. One species *(Typha orientalis)* is native to the south west of WA. Cumbungi was the Australian Aboriginal name for the plant which is known as bullrush and cattail in other parts of the world. It is a tall growing plant (to 2 m) with grass - like leaves and a strong stem.

Its uses are many and varied. As a food, the pollen (rich in protein, carbohydrate, oil, sulphur and phosphorous) can be used as an additive to flour, with a mix ratio of up to 1:1. The young, white spring shoots may be cut a few centimetres below the ground, steamed to make a pleasant vegetable and eaten. Young stems can be peeled and steamed or used in stews or finely cut for a salad. The flower head whilst still green can be steamed and eaten as a corn cob.

Tubers of the roots can be cooked like potatoes and have a nutty flavour. The roots are high in starch and can be dried and ground into a sweet flour, which compares nutritionally to rice and corn flour. One hectare can yield 7,000 kgs.

The American Indians crush and boil the roots which yield a syrup, a favourite in their diet. Oil can be pressed from the seed and the left over meal is suitable as a stock feed. The flour has been successfully fermented to ethyl alcohol.

As a pulp source, cumbungi can be used for making paper. The paper is strong and difficult to bleach so would only be useful as a packaging paper and for cardboards. The leaves yield a soft fibre which can be used in mats, baskets, chair seats and woven articles. Because they swell when wet, the leaves are reportedly good for caulking cracks in houses, barrels and boat building. Fibre can be extracted chemically to provide 7 - 10 tonne/ha of fibres closely resembling jute.

As a water filter plant, cumbungi absorbs many nutrients and contaminants such as PCPs. It seems to have a high salinity tolerance. Its presence around bodies of water can shade direct sun and slow winds, hence reducing evaporation. It is an important food and shelter plant for wild life and is useful in stabilising banks for soil and water conservation.

Zizania aquatica (wild rice)

Family: POACEAE (GRAMINEAE)

A native to the north western USA and southern Canada, this broad - leaved grass grows on stream banks, marshes and shallow ponds. The plant may grow to 3 m and is best suited to fresh water about 1 m deep. The wild rice seed is high in vitamin B and is easily digested. The green seed requires no cooking and it is sufficient to pour boiling water over it, but the dried seed has to be cooked for an hour. The American Indians ate it boiled with blueberries or maple syrup. A closely related species *Zizania caducifolia (syn. Zizania latifolia)* is cultivated in China, Vietnam and Japan.

UTILITY PLANTS OF MARGINS AND WATER MEADOWS

Mentha spp (mints)

Medicinal and aromatic.

Pennisetum spicatum, syn. Pennisetum typhoides (pearl millet)

Family: POACEAE (GRAMINEAE)

Probably a native of Africa, this annual plant has been cultivated for its seed for over 300 years. Yields of 100 tonnes/ha have been recorded and it requires about 120 days to mature. The seed is said to be immune to weevil attack and can be stored in bins and tanks for up to seven years.

Phalaris arundinacea (reed grass, reed canary grass)

A bulky grass used for animal bedding and fodder. It is a good quail and duck forage plant.

Vaccinium spp (blueberry)

Xanthosoma spp (tania, yautia, cocoyams)

Family: ARACACEAE

These plants can grow in soil too damp for conventional root crops such as potatoes, sweet potatoes and yams. There are about 40 species of these plants which are native to the Americas, but only about 6 are important sources of food. They have a central tuberous root (corm) surrounded by smaller tubers (cormels) which are about the size of potatoes. Corms are used for animal feed and for replanting while cormels are a valued source of human food, used in much the same way as potatoes, with which they compare well nutritionally. The tender leaves and shoots are used as a spinach - like vegetable. Some varieties can yield cormels in as short a time as 3 months. In dry areas they can be grown under irrigation.

DIFFICULT SITES

SALT TOLERANT FODDER SPECIES

It is common practise in saline, waterlogged conditions to plant into mounds 200 - 300 mm above normal ground level. Such mounds can be fairly quickly created by use of a grader blade on a tractor. The mounds should, where possible, follow contours.

Salt affected land should be fenced from stock. As useful fodder species become established, stock can be periodically turned onto these areas.

By maintaining a cover on salt affected land, the farmer can: -

1. Reduce evaporation from the soil (by shading from sun and offering wind protection), which is a contributing factor to increased salt.
2. Reduce the amount of soil erosion from otherwise bared earth.
3. Increase transpiration, thus lowering the water table.

GRASSES (SALT FODDER)

***Potypogon monspeliensis* (beardgrass)**

A slender, tufted annual growing to 15 cm. It has become naturalised in parts of Western Australia. Salt tolerant in areas receiving more than 450 - 500 mm rainfall.

***Phalaris truncata* (canary grass)**

This short - lived, self - seeding, tufted perennial will withstand rainfalls from 350 - 1000 mm, from seashore to 300 km inland. It grows poorly on light or sandy soils. It is extremely resistant to water stress, surviving many months in completely dry soil.

***Puccinellia ciliata, Puccinellia capillaris* (puccinellia)**

A perennial, summer - dormant grass which forms tussocks 10-70 cm high. It is nutritionally equivalent to annual rye grass. It is suited to areas with 350 mm or more rainfall and is tolerant of winter waterlogging. Mature tussocks are a good source of summer feed and the autumn growth can also be grazed.

***Lolium rigidum* (rye grass)**

An annual, tolerant of hot, dry conditions and successful in areas with rainfall from 100 - 1200 mm. Seed heads can become toxic to animals.

***Paspalum distichum* (salt - water couch)**

Suited to summer - damp bogs, gullies and seepage areas, it is tolerant of water containing up to 14,000 ppm total soluble salts. It produces valuable winter feed in the summer months.

***Oryzopisis miliacea* (smilo, millet grass)**

This perennial, clumped grass grows to about 1 m. A native to the Mediterranean, it has become naturalised in the south west. It will tolerate shallow and calcareous soils and has been known to grow in rainfalls as low as 100 - 150 mm. Smilo will survive for years, practically without water. There is no summer dormancy provided water is available in the soil. Although germination is slow, this is an extremely competitive plant once established. Yields may reach 12 tonnes dry matter/ha/yr (protein 12 - 15%, digestibility 65%). Under annual rainfalls of 450 - 500 mm, old growth becomes wiry and unpalatable. Smilo is moderately salt tolerant. Sown pastures of smilo have been observed to last for at least 15 years.

***Fetescue elatior, subsp arundinacea* (tall fescue)**

A summer - dormant, tufted perennial, which is extremely resistant to water stress, surviving many months in dry soil. It requires a minimum rainfall of 350 - 400 mm and will withstand high salinity levels. In the Sahel, under irrigation (700 - 800 mm), with water containing 4000 - 5000 ppm salts, yields are still in the order of 8 - 10 tonnes dry matter per ha. Tall fescue has been known to cause lameness (fescue foot) and death in cattle, so it should not be fed in large quantities for long periods of time.

***Agropyron elongatum* (tall wheat grass)**

A perennial, native to southern Russia and Asia minor where it grows in sea shore marshes. It was introduced into Australia more than 50 years ago. It is well adapted to poorly drained saline soils. Best growth occurs where the soil dries out in the summer. It can be grazed once established. It is also suited to marginally saline, well drained, summer moist soil in rainfalls of over 350 mm. Direct sown from seed.

Arundo donax (giant reed)

Often wrongly called a bamboo, this vigorous perennial has thick underground stems from which new stems arise. A native to the Mediterranean region it was introduced into Western Australia as an ornamental plant and has since colonised many damp areas. Survives in inundated, saline water courses in the south west.

COMPANION LEGUMES (SALT FODDER)

No treatment of grasses for pasture would be complete without accompanying legumes to fix nitrogen into the soil.

***Trifolium fragiferum* (strawberry clover)**

Native to north Africa, in areas with rainfall in excess of 300 mm. It is a creeping perennial adapted to heavy, poorly drained soils, often fairly saline and alkaline and grows in association with tall fescue *(Agropyron elongatum)*. It is summer dormant and capable of withstanding long periods of total drought. It is very salt tolerant.

***Hedysarum carnosum* (fleshy sulla)**

A biennial, native to Libya, Tunisia and Algeria with rainfalls from 100 - 350 mm. It occurs naturally on medium to fine - textured saline and alkaline soils. Salt tolerance is high, with irrigation from waters having salt concentrations of 8000 - 10000 ppm salt giving fair yields. Palatability to stock is high.

***Hedysarum coronarium* (sulla)**

This biennial native of north Africa and southern Italy, requires deep, fine - textured calcareous soils. It is fairly resistant to water stress, very sensitive to waterlogging and has a mild to fair resistance to salt. Minimum rainfall requirements are 350 mm. Yields of over 20 tonnes dry matter/ha/year have been recorded but 5 - 10 tonnes are more likely. It has potential as a nectar producer for a bee forage system.

SHRUBS (SALT FODDER)

***SALTBUSH* (Atriplex spp)**

These plants have been found to actually concentrate salt onto the surface of their leaves and could be used for removing salt from the soil. Yields of over 10 tonnes/ ha/year are possible for some species. Some species are Australian natives and can exist in rainfalls less than 300 mm. Better growth rates are experienced in non - saline soils.

***Atripiex versicaria* (bladder saltbush)**

A perennial shrub with woody, brittle stems, reaching a height of 60 - 70 cm and adaptable to a wide range of soil types. Crude protein 11.1 - 18.4%, digestibility 58%

***Atripiex nummularia* (old man saltbush)**

A perennial shrub to 3 m in height, it is found in arid regions of ail mainland states and has high nutritive value and digestibility. Crude protein 17.0 - 21.9%, digestibility 68 - 74%

***Atripiex rhagodioides* (riversaltbush)**

A native of NSW, SA, Vic and WA, this is a spreading bush to 1 m, attaining widths up to 4 m: It is drought and frost hardy, preferring light soils in an open sunny position. The prostrate branches form roots, so it is easily multiplied.

***Atriplex undulata* (wavy leaf saltbush)**

This spreading shrub is native to Argentina and grows to 0.5 m tall and 2 - 3 m wide. The prostrate branches form roots, so it is easily multiplied. As an autumn reserve, it provides 900 sheep grazing days per hectare in a 350 mm rainfall area.

***Atripiex halimus* (North African saltbush)**

***Atripiex canescens* (four winged saltbush)**

This species is endemic to North America, grows to heights of 1 - 3 m on dunes in central Utah and has a high growth rate. Nutrition 18 - 20% protein, digestibility 63.5%, arid low toxicity with increasing salinity.

***BLUEBUSH* (Maireana spp)**

Native to Australia these species are generally good companions to the saltbushes.

***Maireana brevifolia* (small - leafed bluebush)**

A native to the WA wheatbelt, reaching up to 0.9 m in height and 1.5 m wide, it does not tolerate waterlogged soil. Crude protein 15 - 26%.

***Maireana sedifolia* (pearl bluebush)**

One of the major shrubs of the Nullarbor Plain, it grows to a height and width of 1 m, preferring calcareous soils in which limestone lies close to the surface. Crude protein 17.2%

***Maireana pyramidata* (black bluebush, shrubby bluebush)**

Growing to a height of nearly 2 m, it is confined to calcareous red and red - brown soils. Crude protein 15.1 - 22.0%, digestibility 58%.

***Maireana aphylia* (cotton bush)**

A much branched perennial shrub, to a height and width of I m, it prefers clay and clay loam soils.

HOP BUSH *(Dodonea viscosa)*

Grows in areas of annual rainfalls less than 250 mm.

SAMPHIRES *(Halosarcia spp)*

Native to waterlogged saltlands of Western Australia.

SALT TOLERANT TREES

***Tamarix articulata, syn. Tamarix aphylia* (Athel tamarisk)**

A vigorous, bushy, pine - like tree. It will tolerate most soils, in frost free districts and requires a minimum of 350 mm rainfall. WARNING: most tamarisks cause salinisation of the upper soil. Their extensive roots extract all soluble salts from the soil, excrete the salts on the leaves, and return them to the topsoil with litter fall. They reduce crop yields for up to 50 m.

PAPERBARKS *(Melaleuca spp)*

Family: MYRTACEAE

Many of these are valuable for honey and essential oils.

***Melaleuca stypheloides* (prickly paperbark)**

A fast growing tree (6 - 18m), found in swampy coastal sites in eastern Australia. It is tolerant of saline, sandy, wet and heavy soils. It is drought and frost tolerant.

Melaleuca cymbifolia

Melaleuca thyroides

This is an evergreen shrub reaching 2 m tall and 2 m wide, native to Western Australia. It is frost and drought tolerant and has good tolerance to water logging.

***Melaleuca bracteata* (white cloud tree)**

A small (to 7 m), spreading (to 5 m), evergreen bush native to all mainland states of Australia except Victoria. It is drought and frost tolerant and prefers heavy to medium soils in an open sunny position.

Melaleuca calycina

Melaleuca cardiophylla

Melaleuca glomerata

A small (to 6m and 3 m spread) evergreen tree native to Western Australia, South Australia, New South Wales and Northern Territory. It is frost and drought tolerant and prefers medium to light soils in an open and sunny position.

Melaleuca nervosa

Melaleuca pauperiflora

Melaleuca subtrigona

***Melaleuca uncinata* (broom honey myrtle)**

Melaleuca acuminata

***Melaleuca brevifolia* (mallee honey myrtle)**

Melaleuca hamulosa

Melaleuca preissiana

***Melaleuca lanceolata* (moonah, Rottnest Island pine)**

light amber honey in summer.

Casuarina spp

Casuarina obesa

***Casuarina glauca* (swamp sheoak)**

***Casuarina cristata* (black sheoak)**

WATTLES *(Acacia spp)*

Acacia ampliceps

North western Australia

Acacia auriculiformis

Tropical and coastal Australia

Acacia cyclops

South west coastal Australia

Acacia floribunda

Central to south eastern coastal Australia

Acacia harpophylla

South eastern NSW - northern Queensland, Australia

Acacia ligulata

All mainland states, north and south Australia

Acacia pendula

Central to south east Australia

Acacia pycnantha

South east Australia

Acacia redolens

Western south coastal Australia

Acacia retinodes

South eastern Australia

Acacia saligna

Acacia salicina

Acacia stenophylla

From tropics to central Victoria, all mainland states, Australia

Acacia transluscens

North western Australia

Acacia xiphophylla

North western Australia

Albizia lophantha

Eucalyptus spp

Eucalyptus sargentii

Eucalyptus occidental

Eucalyptus spathulata

Eucalyptus platypus var heterophylla

Ziziphus mauritiana

grafted onto *Ziziphus nummularis.*

Manilkara zapota

grafted onto *Manilkara hexandra*

***Dalbergia sissoo* (sissoo)**

A fast growing leguminous tree (to 30 m) which adapts well to semi - arid conditions (may only reach 10 - 15m without irrigation). It grows in a temperature range from below 0°C to nearly 50°G and is considered frost hardy. The rainfall ranges from 500 - 2,000 mm and it can tolerate arid conditions. It grows from sea level up to 1500 m altitude.

It occurs on alluvial soils in and along the banks of rivers and the beds of streams. It does not grow well on heavy clay soils. It has long superficial roots which send up suckers when damaged. It has great value in erosion control.

The wood is hard, elastic and close grained. The white sapwood is durable and valued for furniture. It is a good carving and bending wood. It is used for veneer, handles, cartwheels, boat building, ploughs, toys, tool and sporting equipment handles, railway carriages, and structural work.

It is a good firewood with a specific gravity of 0.64 - 0.7, with a density of 5,200 kcal per kg in the heartwood and 4,900 in the sapwood. It also is used to produce charcoal. It can be managed in coppice rotation.

Young branches and leaves are used as fodder. Deer and cattle browse the young plants.

***Colophospermum mopane* (mopane)**

A moderately tall (to 23 m) leguminous tree native to central and southern Africa. It grows on poor soils with bad drainage where not even useful grasses will grow.

It withstands high summer temperatures but only mild frosts. Heavy frosts may cause the crowns to die back. The rainfall ranges from 125 - 800 mm. It generally grows in shallow compacted clay, alkaline and badly drained soils, but best growth occurs on rich deep alluvial soils. It has an amazing ability to withstand dry, saline sites. It grows best below 900 m altitude.

Young plants produce root suckers. Seedlings may be suppressed by grasses.

The leaves are readily eaten by stock and retain nutrient values even when they have fallen. The durable wood is used for pylons in bridge construction, mine timbers, railroad ties, and fence posts. It is also used to make parquet and as a carving wood. Because the wood is so hard, heavy saws are required. It should be cut while green.

It is said to be the best firewood in Africa. The dark wood has a specific gravity greater than 1.0 and it burns slowly and quietly while giving off great heat. The trees coppice vigorously after fire, frost, or felling.

***Derris indica* (Indian beech)**

PLANTS WHICH SURVIVE RIGHT TO THE OCEAN

GROUND COVERS (COASTAL)

***Ambrosia hispida* (creeping ragweed)**

A good sand binder.

***Apium prostratum* (sea celery)**

A small, squat herb which grows on coastal headlands and dunes, margins of brackish swamps, and on saline stretches of river banks throughout the south of Australia. It has a striking resemblance to *Apium graveolens,* the wild ancestor to celery from Europe and Asia.

It has been used as a parsley to allay scurvy in the eighteenth century. Although the stems are too small to use as a celery, it has potential to be bred as a vegetable.

Apium annuum and Apium insulare

Other natives of Australia which are worthy of trials.

***Arctostaphylos uvaursi* (bearberry, kinnikinik)**

A trailing or creeping shrub (rarely exceeding 75 cm) of the northern temperate region, it is hardy to frost. The red berries are fairly bland and mealy, and are usually eaten cooked, preserved or made into jams, jellies, marmalades, sauces and pastes. The dried leaves are used as tea in some parts of Russia.

***Arctotis stoechadifolia* (African daisy)**

This bushy, creeping perennial (to 25 cm) is native to South Africa. It is half hardy to frost and is an extremely good sand binder. In sand it builds organic matter well. It survives hot dry summers. It has proven to stabilise heavy soils such as dam walls .

***Armeria martima* (sea pink)**

A hardy, perennial, creeping, frost hardy, native shrub of Eurasia. It covers sand banks readily.

***Batis martima* (saltwort, beachwort)**

A spreading, prostrate shrub with creeping stems which is usually found in mangrove swamps and salt marshes. It is native to Florida.

***Bivonea stimulosa* (Finger rot, spurge nettle, tread softly)**

This shrub to 1 m is a native of Florida. It is covered with stinging hairs.

***Calluna vulgaris* (heather)**

This frost hardy, evergreen shrub to 600 mm is native to Europe. When grown in masses it is effective as erosion control.

***Carpobrotus spp* (pigface, karkalla)**

Native of southern Australia. The leaves are thick and fleshy, triangular in cross section, often reddish. The flowers are purple and the fruits are purplish - red. They are common creepers of the sand dunes, beaches and headlands. *Carpobrotus rossii* and *Carpobrotus modestus* extend well inland.

It is said to be one of Australia's tastiest fruits, tasting somewhat like salty apples. The leaves were often eaten cooked by Aborigines to salt their meat. The dried fruit was also eaten.

In Queensland, the mucilaginous juice from the leaves is used to treat midge bites and the stings from Portuguese man - of - war or blue bottle jellyfish. The related South African species contains mesembrine which has a physiological action similar to, but weaker than, cocaine. The juice of both the Australian and South African species is used, traditionally, to sooth burns and scalds.

***Sarcocornia quinqueflora* (chicken claws, beaded glasswort)**

This species forms extensive colonies on tidal mudflats. It has succulent, jointed leafless stems rarely growing as tall as 50 cm.

The fleshy stem absorbs the flavour of pickles, but the woody centre within each stem is a nuisance. The English native, *Sarcocornia stricta* is a preferred plant for this purpose.

***Sesuvian portulacastrum* (sea purslane)**

A fleshy - leaved, shrubby herb, native to beaches and mudflats of northern Australia and New South Wales. The leaves are reported to make an excellent vegetable and pickles ingredient.

***Suadea australis* (sea blight)**

A fleshy - leaved plant native to most of the coast of Australia. It is a shrubby herb (15-30 cm) of saltflats, inland saltpans and sandbanks behind mangroves.

Early settlers used the plant as a vegetable and in pickles.

***Tetragonia tetragonioides* (warrigal cabbage, New Zealand spinach)**

A shrubby, creeping herb common to sheltered beaches, saltmarshes, arid woodlands and plains, extending into central Australia. Also native to the coast of New Zealand.

The only plant native to Australia to be cultivated internationally as a vegetable. The leaves are cooked as for spinach and the succulent young leaves can be eaten raw in salads.

HEDGE PLANTS (COASTAL)

Acanthocerus floridanus

Thorny

Alyxia buxifolia

Carissa grandiflora, syn. Carissa macrocarpa (natal plum)

Thorny plant with edible fruit

Coccoloba uvifera (sea grape)

A large bush or small tree (to 6 m) with scarlet coloured foliage. A native of Florida and the Caribbean, it is an extremely hardy tree able to withstand wind and salt spray. It can grow with its roots partly in the sea. It is however, fairly tender to frost.

Sea grape is dioecious. The fruit is reddish purple to off white and may be eaten out of hand and in jellies, jams, drinks, syrups and wines.

Coprosma baueri

Coprosma repens (New Zealand mirror plant)

Correa alba (Cape Barren tea)

A native of the Bass Straight in Australia, the leaves were once used as a tea substitute.

Escallonia macantha

Euphorbia tirucalli

Probably a good honey plant.

Grlselinia littoralis

Hakea suaveolens

A honey plant

Hylocereus undatuns

Juniperus barbedensis

Leptospermum laevigatum (coast tea tree)

The dried leaves are used as a tea; a good honey plant.

Melaleuca pubescens

A honey plant

Olearia haastii

Olearia macrodonta

Pittosporum crassifolium

Pittosporum tobira

Quercus ilex (holm oak)

See Oaks section

Raphiolepis spp

Tamarix spp

Tend to concentrate salt into leaves and consequently onto the ground around the plant. The stems exude a manna which is used in confectionery, sweetmeat, porridge and refreshing beverages.

Ulex europaeus (gorse)

A native of Europe and north Africa. The flower buds are pickled in vinegar and eaten in salads. The leaf buds are used as a tea substitute. The flowers can be used to make wine.

Westringia spp

SHRUBS (COASTAL)

Actinostrobus pryamidalalis (Swan River cypress pine)

A small ornamental conifer to 3 m, which is noted for its tolerance of salty land.

Echylaena tomentosa (ruby, barrier, or Sturt's saltbush, plum puddings)

A small shrub (to 1 m), found throughout arid Australia in nearly all habitats. It is well adapted to saline and marshy conditions.

The fruit is salty sweet to taste. The leaves can be boiled and eaten as a vegetable. In the Macdonnel Ranges the Aborigines soaked the fruit in water and drank the liquid like a sweet tea.

Baccaris halimifolia (silvering, groundsel bush, salt bush)

A frost hardy, deciduous shrub from 1 - 3 m.

TREES (COASTAL)

Aviicenna marina (grey mangrove, white mangrove)

The common mangrove tree of estuaries, river banks and sheltered coasts of Australia, these trees take their oxygen from specialised roots which thrust up from the mud. The soil is typically soft, moist, saline and has no profile.

The seed, after three separate boilings, looks and tastes similar to avocado. The golden - yellow flowers yield nectar which makes a light, amber - coloured, pleasant honey from mid autumn to early winter. The leaves are palatable to stock.

Companions include *Casuarina glauca* (swamp oak) in the south on less inundated margins and *Ceriops tagal* (small stilted mangrove) in the north. It is tolerant of some frost.

The wood is extremely tough, hard, has conspicuous brown growth rings, density about 880 kg/cu m and has been used for knees and elbows in boat building.

Betula populifolia (grey birch, white birch, oldfield birch)

A tree to 9 m which thrives on sandy or swampy soil. It is extremely frost hardy. Best planted in groves.

Chrysobalanus icaco (cocoa palm, icoaco palm)

An extremely hardy shrub or tree (to 12 m) which has branches which creep in all directions*. It is native to south Florida and the Caribbean. It grows in dense clumps on the sea shore and in both fresh and saline swamps, extending well inland and into mountain *regions, so it* may well prove frost tolerant. The fruit was an important food of the Seminole Indians. It can be eaten raw, stewed with sugar, dried like prunes or made into jellies. The seed kernels are roasted and eaten. In preserves the fruit is pierced right through to the kernel and the flavour of the fruit penetrates into the seed which is taken from the shell and eaten.

Elaeagnus angustifolia (Bohemian olive, Russian olive, trebizond date, oleaster)

A deciduous small tree to 12 m and about 2 m wide but sometimes quite shrubby. It is native of the Mediterranean through to SW Asia. It is an extremely tough seaside plant which is hardy to frost and very cold temperatures (- 34°C) and grows right to the sea in France. It has a symbiotic relationship with *Frankia spp,* nitrogen fixing soil microbes. It prefers dry, well drained, alkaline soils in a sunny, open position.

It is a good pioneer species, but has thorns. It occurs naturally with Tam*arix gallica.*

The yellow, sweet berries are eaten fresh or made into pies, sauces, jams, jellies, sherbets and wines. The berries provide poultry forage in late summer.

It is a good windbreak and hedge species which provides bird habitat. It is used for erosion control.

Metrosideros tomentosa (New Zealand Christmas tree)

A large tree (to 10 m) which is somewhat frost hardy. It is commonly found growing with its roots dangling into the sea. It is hardy to salt spray.

Myoporum laetum

A native to New Zealand, this fast growing evergreen tree (to 6 m) is very hardy in exposed places. It is recommended for planting by the sea.

Nyssa sylvatica (black tupelo, pepperidge, black gum, sour gum)

A frost hardy tree to 30 m. The fruit is edible raw and useful in preserves.

Also *Nyssa aquatica* and *Nyssa ogeche* would be worthy of trial.

Persea borbonica (red bay, bull bay)

An evergreen, frost hardy tree, occurring in low areas near the sea along the eastern coast of USA. A relative of the avocado, the leaves are used as flavouring similar to bay leaves. It is also made into a tea.

Populus tremula (European aspen)

A small, suckering, open - headed tree, native to Europe, which withstands full exposure to the sea. It is hardy to frost and extremely resistant to salt.

Salix caprea (goat willow, sallow)

A hardy, Eurasian, small deciduous tree which stands well in full exposure to the sea. It is frost hardy.

Sapindus saponaria (soapberry)

A small, evergreen tree (to 8 m) native to Europe, which grows well in places where salt water overflows frequently.

Swietenia mahagoni (Madeira redwood, mahogany, West Indian mahogany)

An evergreen tree to 24 m and native of southern USA and the Caribbean. It is common in low lying limestone swamps close to the sea, where it produces wood of exceptional quality. It survives just above saline water. It is considered frost tender.

Taxodium distichum (bald cypress)

A swamp tree of the everglades. It has been found to be quite frost hardy.

OTHER PLANTS WORTHY OF TRIAL (COASTAL)

Argania spinosa (argan)

Asparagus officinalis (asparagus)

Chenopodium quinoa (qulnoa)

Crithmum maritimum (sea fennel)

Distichlis palmeri (Palmer saltgrass)

A perennial to about 0.5 m which grows in tidal flats and salty marshlands off the Gulf of California and thrives with tidal inundation of sea water. The seed falls to the water and is washed ashore where it is traditionally harvested by the Seri Indians.

Once established, this plant should not need replanting. It is fast growing and extremely dense as the plant spreads by means of rhizomes.

Field tests with hybrid cultivars are producing 1 tonne of grain to the hectare.

Distichlis spicata (sail grass)

There are distinct inland and sea shore ecotypes. 20,000 hectares of salt flats are under cultivation near Mexico City for cattle fodder.

Kosteletzkya virginica (seashore mallow)

Leptochloa fusca (kallar grass)

A highly salt tolerant perennial forage species. It grows best on permanendy wet soils in tropical and southern Africa.

Mesembryanthemum crystallinum. (ice plant)

Pennisetum typhoides (pearl millety

Portulaca oleracea (common purslane)

Salsola iberica (Russian thistle)

Salt and drought tolerant annual with a crude protein of 15 - 20% and a similar amino acid breakdown to alfalfa.

Santalum acuminatum **(quandong)**

Teticornia australasica, Teticornia verrucosa **(teticornia)**

Typha spp **(cumbungi)**

See water plants

Zostera marina **(eelgrass)**

PLANTS TOLERANT OF ALKALINE SOIL

Acacia ampliceps (salt wattle, jila jila)

Acacia aneura (mulga)

Acacia bivenosa (two - veined acacia)

Acacia cuspidifolia (spine - tipped wattle)

Acacia cyclops (coastal wattle)

Acacia harpophylla (brigalow, spearwood)

Acacia ligulata (sandhill wattle)

Acacia notabilis (Flinders wattle)

Acacia pycnantha (Australian golden wattle)

40% tannin in bark.

Acacia ramulosa (horse mulga)

Acacia salicina (cooba)

Acacia saligna (golden wreath wattle)

Acacia sclerosperma (large seeded cooba)

Acacia sibilans (whispering myall)

Acacia stenophylla (river cooba)

Acer negundo, syn. Negundo aceroides (box elder, maple)

Acer platanoides (Norway maple)

Acer pseudoplatanus (maple)

Aesculus spp (horse chestnuts and buckeyes)

Agave spp

One of the main food sources of Californian desert Indians; leaves source of sisal fibre, juice for tequila

Agonis flexuosa (peppermint tree)

Honey

Albizia lophantha (crested wattle, spiked acacia)

Allocasuarina verticiiiata

Araucaria heterophylla (Norfolk Island pine)

Coastal; salt tolerant to beach front.

Arbutus unedo **(Irish strawberry tree)**

Atriplex nummularia **(old man saltbush)**

Baccaris halimifolia **(groundsel bush)**

Pollen in autumn.

Baccaris patagonica

Banksia ashbyi

Nectar in spring.

Banksia integrifolia **(coast banksia)**

Nectar, good dark honey in autumn to winter.

Banksia marginata **(silver banksia)**

Banksia omata

Berberis spp **(barberry)**

Edible fruit.

Brachycome iberidifolia **(Swan River daisy)**

Hardy wildflower.

Brachysema lanceolata **(Swan River pea bush)**

Hardy legume.

Buddleia davidii **(butterfly bush)**

Hardy.

Bursaria spinosa

Bush with summer flowers.

Buxus sempervirens (box)

Valued timber.

Calilstemon viminalis **(weeping bottlebrush)**

Hardy, evergreen tree.

Callitris columellaris **(Murray pine)**

Hardy, evergreen tree.

Callitris preissii **(Rottnest Island pine)**

Hardy, evergreen tree.

Calocephalus brownii **(cushionbush)**

Hardy, evergreen tree; salt spray resistant.

Calothamnus quadrifidus **(netbush)**

Hardy, evergreen tree.

Carpinus betulus **(common hornbeam)**

Deciduous tree, hedge plant.

Caryopteris incana **(blue spirea)**

Deciduous shrub.

Castanea spp **(chestnut)**

Casuarina cristata **(black sheoak)**

Casuarina cunninghamiana **(river sheoak)**

Casuarina humulis

Hardy, evergreen tree; salt spray resistant.

Ceanothus spp

Shrubs; *Ceanothus americanus* as a wash for skin cancers and tea substitute.

Cedrus atlantica **(Mt. Atlas cedar)**

Ceratonia siliqua (carob)

Chamelaucium uncinatum **(Geraldton wax)**

Salt tolerant, evergreen shrub.

Choisya spp

Chrysanthemum frutescens **(marguerite)**

Evergreen shrub.

Cistus spp (rock rose and sun rose)

Evergreen shrubs; masses of flowers.

Clianthus formosus **(Sturt's desert pea)**

Colophospermum mopane (mopane)

Comusmas **(Corneliancherry)**

Deciduous tree with edible fruit

Correa alba

Hardy, evergreen shrub; salt tolerant; leaves a tea substitute.

Correa decumbens

Hardy, evergreen shrub.

Correa mannfi

Cortaderia selloana (pampas grass)

Cotoneasier spp

Evergreen and deciduous shrubs; poultry forage, honey.

Crataegus cordata **(Washington thorn)**

A close relative to common hawthorn, growing to 6 - 10 m. Prefers a cool climate and is frost hardy. The scarlet berries persist into winter, and the foliage turns red in autumn.

Crataegus oxyacantha (English hawthorn)

Honey; berries as poultry feed; seedlings are woven to form hedge.

Derris Indica **(Indian beech)**

Deutzia~spp

Hardy, deciduous shrubs,

Dfptolaena spp

Hardy, evergreen shrub; somewhat salt tolerant.

Echkmvczmdicans **(pride of Madeira)**

Evergreen bush; good honey and flowers in winter and spring.

Baeagnus angustifolia **(Bohemian olive, Russian olive, trebizond date, oleaster)**

Epacrlsimpressa **(common white heath)**

Evergreen shrub.

Eremophila glabra (tarbush)

Hardy, evergreen shrub.

Eremophila longifolia (berrigan)

Hardy, evergreen shrub; Australian Aboriginal cure for colds and sores.

Wemophila oppositifolia **(twin - leaf emu bush)**

Hardy, evergreen bush.

Eremophila santalina

Wcallonia spp

Hardy, evergreen shrubs and trees of South America.

Eucalyptus camaldulensis

Eucalyptus citriodofa

Eucalyptus diversifblia

Eucalyptus erythrocorys

Eucalyptus gomphocephala

Eucalyptus lansdowneana

Eucalyptus leucoxyfon

Eucalyptus nutans

Eucalyptus occidentalis **(swamp yate)**

Eucalyptus platypus

Eucalyptus spathulata

Eucalyptus torquata

Eucalyptus woodwardii

Euonymus spp

Fruits and seeds used for food colouring.

Fagus sylvatica **(common beech, European beech)**

Forsythia spp

Frost resistant, evergreen shrubs from China.

Fraxinus excelsior **(European ash)**

Frost resistant, deciduous, spreading tree (to 40 m tall); winged fruits pickled; leaves used to adulterate tea; edible manna.

Fraxinus ornus (manna ash)

Frost resistant, deciduous spreading tree (to 16 m tall).

Fuchsia spp

Ornamental; edible flowers and fruit.

Garrya spp

Evergreen shrubs, leathery leaves, suit coastal exposure.

Gleditsia triacanthos **(honey locust)**

Greviliea ilicifolia **(holly grevillea)**

Frost resistant, evergreen shrub; honey; wildflowers.

Grevillea leucopteris **(plume grevillea)**

Hardy, evergreen shrub; honey; wildflowers

Grevillea pauciflora

Frost resistant, evergreen shrub; honey; wildflowers.

Grevillea vestita

Hardy, evergreen shrub.

Hakea suaveolens

Hardy, evergreen shrub; honey; wildflowers.

Hebe spp

Frost resistant, evergreen shrub.

***Hedysarum carnosum* (fleshy sulla)**

***Hedysarum coronarium* (sulla)**

***Helianthemum spp* (rock rose)**

Herb is astringent, tonic, emetic.

Hibiscus spp

Many species provide food.

Hypericum spp

Large genus; some medicinal and food uses.

***Inga edulis* (pacay, ice cream bean)**

***Juniperus communis* (juniper)**

Hardy, evergreen shrub; berries are eaten and used to flavour gin, liqueurs, cordials, meat, beer and to make tea; medicinal uses.

***Juniperus horizontalis* (creeping juniper)**

Evergreen, spreading shrub; berries as both tea and coffee substitute.

***Juniperus pfitzerana* (Pfitzer juniper)**

***Juniperus sabina* (savin juniper)**

Hardy, evergreen shrub.

Juniperus sargentii

Kerria spp

***Kochia sedifolia* (pearl bluebush)**

Kolkwitzia spp

Lagunaria patersonia

***Laurus nobills* (sweet bay laurel)**

Evergreen, Mediterranean tree; leaves for flavouring and herbal tea; berries distilled to make liqueur.

***Lavandula spp* (lavender)**

Hardy evergreen shrubs; essential oils; culinary; medicinal.

***Leptospermum laevigatum* (coastal tea tree)**

Evergreen shrub.

Ligustrum spp

***Lupinus arboreus* (tree lupin)**

***Maireana pyramidata* (black bluebush, shrubby bluebush)**

***Maireana sedifolia* (pearl bluebush)**

***Malpighia glabra* (acerola, Barbados cherry)**

Malus spp

Melaleuca ericifolia

Melaleuca halmaturorum

Melaleuca hypericifolia

***Melaleuca lanceolata* (western tea tree)**

Honey, pollen.

Melaleuca nesophila

Melaleuca wilsonii

***Melia azedarach* (cape lilac, white cedar)**

***Morus nigra* (black mulberry)**

***Myoporum insulare* (boobialla)**

Evergreen shrub; coastal; fruit is edible but salty and bitter.

***Myoporum platycarpum* (sugarwood)**

Evergreen tree with fragrant timber like sandalwood; manna is laxative.

***Olearia spp* (daisy bush)**

Evergreen shrubs; dyes.

***Oryzopsis miliacea* (smilo, millet grass)**

***Phoenix dactylifera* (date palm)**

***Phyllostachys bambusoides* (Madake giant timber bamboo)**

***Pinus griffifhii, syn. Pinus wallichiana* (Indian blue pine)**

***Pinus johannis* (Johannis pinon)**

***Pistacia atlantica* (butum, Mt Atlas pistachio)**

***Pittosporum phillyreoides* (weeping pittosporum, meemeei, cumby cumby, cattle bush)**

Evergreen shrub; Australian Aboriginal medicine to treat cramps and pains; stock feed.

Plumbago spp

Evergreen shrubs and vines.

***Populus alba* (white poplar)**

Populus canescens

Large, deciduous suckering tree.

Prunus spp

***Pyracantha spp* (firethorns)**

Very hardy shrubs to 5 m; berries poultry forage; flowers bee forage.

***Quercus cerris* (Turkey oak).**

***Quercus ilex* (holm oak, holly oak).**

***Quercus robur* (English oak)**

Rhagodia spp

***Rhus spp* (sumacs)**

Many species; some (eg poison ivy) are severe skin irritants; some have edible berries which are also made into lemonade - type beverages and used as a vegetable rennet, a spice and a salt substitute; fruit of *Rhus succedanea* yields a wax once used in Japan for candles.

Ribes spp

Rosmarinus spp

***Salix alba* (white willow)**

***Sambucus spp* (elder)**

Some species have edible fruits, flowers or roots.

Santolina spp

Low evergreen shrubs from Mediterranean, leaves as flavouring.

Senecio spp

Evergreen shrubs of New Zealand; *Senecio reinoldii* for exposed coastal areas.

***Soianum rantonnetii* (Paraguayan nightshade)**

Evergreen, frost resistant shrub.

***Sorbus aria* (white beam)**

Small to medium tree, good for windswept coastal areas and high pollution areas, fruit for jellies, conserves, brandy and vinegar,

***Sorbus intermedia* (Swedish whitebeam)**

Small to medium tree.

***Swietenia mahagoni* (Madeira redwood, mahogany, West Indian mahogany)**

Symphoricarpos spp

Deciduous shrubs.

***Syringa spp* (lilac)**

Hardy, deciduous shrubs; *Syringa vulgaris* has edible flowers.

***Syzygium jambos* (rose apple)**

Tamarix spp

Tecomaria spp

Half hardy; semi - climbing; berries.

***Thrinax spp* (thatch palms)**

***Trifoiium fragiferum* (strawberry clover)**

***Vinca spp* (periwinkle)**

Vigorous, evergreen, trailing shrubs; ground cover for shade and full sun.

Weigeia spp

Hardy flowering shrubs.

Yucca spp

Desert trees; various species have edible fruits, flowers, leaves and roots; fibre from leaves.

Ziziphus jujuba, syn. Ziziphus vulgaris (jujube)

Photinia spp

***Sophora secundiflora* (mescal bean)**

Slow growing, hardy, drought tolerant, leguminous tree growing to 10 m tall; bee forage; seed poisonous.

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